PRJ19-00008 Attachment 054

Preliminary Frontage Technical Information Report

PREPARED FOR:

Issaquah School District No. 411
565 NW Holly Street
Issaquah, WA 98027
Contact: Royce Nourigat / Tom Mullins

PROJECT:

Issaquah High School #4 and
Elementary School #17
4221 228th Ave Southeast
Issaquah, WA 98029
2180412.10

PREPARED BY:

Charles H. Stout, PE
Project Engineer

REVIEWED BY:

Todd C. Sawin, PE, DBIA LEED AP
Principal

DATE:

May 2021

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Principal

DATE:

May 2021

I hereby state that this Preliminary Frontage Technical Information Report for Issaquah High School #4 and Elementary School #17 project has been prepared by me or under my supervision, and meets the standard of care and expertise that is usual and customary in this community for professional engineers. I understand that the City of Sammamish does not and will not assume liability for the sufficiency, suitability, or performance of drainage facilities prepared by me.

Table of Contents

Section 1

Project Overview

1.0 Project Overview

1.1 Purpose and Scope

This report accompanies the civil engineering frontage plans and documents for the Issaquah High School #4 and Elementary School #17 project. The project site is located at 4221 228th Avenue Southeast in Issaquah, Washington 98029. The project site is located within the City of Issaquah, Tax Parcels 1624069029, 1624069001, and 1624069031, however the 228th Avenue Southeast frontage improvements proposed as part of this project are within the City of Sammamish right-of-way. See Figure 1-1 for the TIR Worksheet and Figure 1-2 for the Site Location Map.

Right-of-way improvements follow along the existing 228th Ave SE roadway where it fronts the Issaquah High School and Elementary School project site. Existing sewer and water utilities will be protected within the roadway with a new stormwater conveyance system proposed. Roadway improvements will meet the requirements of the City of Sammamish Roadway Section Principal Arterial Standard Dwg. No. 01-01.

Frontage improvements are located within the City of Sammamish and are subject to the requirements of the 2016 *King County Surface Water Design Manual* (*KCSWDM*) as amended by the City of Sammamish *Sammamish Addendum to the 2016 King County Surface Water Design Manual (Revised 9/25/2019)* (*SASWDM*). This preliminary TIR has been prepared to assist the review of the Land Use submittal package for the Issaquah High School #4 and Elementary School #17 project.

1.2 Existing Conditions

The existing 228th Ave SE right-of-way, where it fronts the project site, is a 72 foot right-of-way with one travel lane in each direction with a paved shoulder on each side of the roadway and no turn lanes or center lanes and no curbs or sidewalks. Both the east and west sides of the roadway are existing forested cover with residential properties to the east and the project site to the west.

The vertical alignment of 228th Ave SE goes from a high point near the south side of the proposed frontage improvements at approximately 487 feet to approximately 415 feet at the north side of the proposed frontage improvements. The roadway slopes at approximately 7%. This existing roadway alignment will be maintained under proposed conditions.

Runoff currently discharges to roadside ditches on the east and west sides of the roadway where it is conveyed north to the northern edge of the proposed frontage improvements where runoff discharges east through residential properties and ultimately discharges to Laughing Jacob's Creek. Refer to Section 3.0 of this report for a description of the existing downstream flow path. The existing discharge locations and eastern right-of-way line will be maintained under proposed conditions.

Table 1 shows a breakdown of the exiting surfaces within the Frontage Basin. This Frontage Basin is split into three separate sections: existing onsite areas that discharge to the roadway, existing onsite areas that discharge to the roadway and will be part of a ROW dedication, and the existing ROW.

Table 1. Existing Frontage Areas

	A_{imp} (ac)	A_{per} (ac)	Total (ac)
Onsite	0.01	3.35	3.36

ROW Dedication	0.02	0.95	0.97
ROW	1.33	0.95	2.28
Total	1.36	5.25	6.61

1.3 Post-Development Conditions

Proposed frontage improvements include two separate roadway sections as shown on the frontage plans. Section A (STA 21+50 ROAD SECTION), from the southern end of the frontage improvements to the intersection of 228th Ave SE and the proposed site's main access, consists of a 22 foot right-of-way dedication on the west side of the right-of-way. Section A consist of a 5 foot shoulder on each side of the roadway, two 11 foot travel lanes going each direction, and one 11 foot turn lane. Section B (STA 27+00 ROAD SECTION), the intersection of 228th Ave SE and the proposed site's main access, consists of a 33 foot right-of-way dedication on the west side of the right-of-way. Section B consists of a 5 foot shoulder on each side of the roadway, an 11 foot right hand turn lane going each direction, two 11 foot travel lanes going each direction, and an 11 foot center no travel lane. Both road sections have curb and gutter on both sides. West of the new curb and gutter, in both sections, there is a 6 foot wide landscape strip, a 6 foot wide sidewalk, and a 1.5' transition area before the proposed right-of-way line; C.O.I. walls are proposed up against the west side of the expanded right-of-way on the project site. East of the new curb and gutter, in both sections, there is a 2' transition area then a block retaining wall with existing grades being matched on the east side of the right-of-way. Along the entire 228th Ave SE frontage improvements, the existing 228th Ave SE asphalt roadway will be protected with only a grind and overlay being proposed. A City of Sammamish stormwater sewer system is proposed under the improved roadway to convey runoff to the City of Sammamish stormwater conveyance system with proposed connection points at the north end of the frontage improvements.

Table 2 shows a breakdown of the proposed surfaces within the Frontage Basin. This Frontage Basin is split into two separate sections: areas to detention and bypass areas.

Table 2. Proposed Leasehold Area

	A_{imp} (ac)	A_{per} (ac)	Total (ac)
Area to Detention	1.70	2.14	3.84
Bypass Area	1.21	1.56	2.77
Total	2.91	3.70	6.61

Section 1.0 Figures

TECHNICAL INFORMATION REPORT (TIR) WORKSHEET

Part 1 PROJECT OWNER AND PROJECT ENGINEER

Project Owner Issaquah School District No. 411
Phone 425.837.7037 (Royce Nourigat)
Address 565 NW Holly Street
Issaquah, WA 98027
Project Engineer Todd Sawin
Company AHBL
Phone 253.383.2422

Part 2 PROJECT LOCATION AND DESCRIPTION

Project Name Issaquah HS #4 and ES #17
DDES Permit # ____
Location Township 24 N
Range 06 E
Section 16
Site Address 4221 228th Ave SE
Issaquah, WA 98029

Part 3 TYPE OF PERMIT APPLICATION

- ☐ Landuse Services Subdivison / Short Subd. / UPD
- ☑ Building Services M/F / Commerical / SFR
- ☑ Clearing and Grading
- ☑ Right-of-Way Use
- ☐ Other ____

Part 4 OTHER REVIEWS AND PERMITS

- ☐ DFW HPA
- ☐ COE 404
- ☐ DOE Dam Safety
- ☐ FEMA Floodplain
- ☐ COE Wetlands
- ☐ Other ____
- ☐ Shoreline Management
- ☐ Structural Rockery/Vault/____
- ☐ ESA Section 7

Part 5 PLAN AND REPORT INFORMATION

Technical Information Report

Type of Drainage Review (circle): $\boxed{\text{Full}}$ / Targeted / Large Site
Date (include revision dates): February 2021
Date of Final: ____

Site Improvement Plan (Engr. Plans)

Type (circle one): $\boxed{\text{Full}}$ / Modified / Small Site
Date (include revision dates): February 2021
Date of Final: ____

Part 6 ADJUSTMENT APPROVALS

Type (circle one): Standard / Complex / Preapplication / Experimental / Blanket

Description: (include conditions in TIR Section 2)

____

Date of Approval: ____

TECHNICAL INFORMATION REPORT (TIR) WORKSHEET

Part 7 MONITORING REQUIREMENTS

Monitoring Required: Yes / No (No boxed)

Start Date: ____________

Completion Date: ____________

Describe: ____________

Part 8 SITE COMMUNITY AND DRAINAGE BASIN

Community Plan : ____________

Special District Overlays: ____________

Drainage Basin: East Lake Sammamish

Stormwater Requirements: Conservation Flow Control and Sensitive Lake Treatment

Part 9 ONSITE AND ADJACENT SENSITIVE AREAS

- ☑ River/Stream Laughing Jacob's Creek
- ☐ Lake ____________
- ☑ Wetlands ____________
- ☐ Closed Depression ____________
- ☐ Floodplain ____________
- ☐ Other ____________
- ☐ Steep Slope ____________
- ☐ Erosion Hazard ____________
- ☐ Landslide Hazard ____________
- ☐ Coal Mine Hazard ____________
- ☐ Seismic Hazard ____________
- ☐ Habitat Protection ____________
- ☐ ____________

Part 10 SOILS

Soil Type	Slopes	Erosion Potential
Alderwood gravelly sandy loam	8-15%	Low
Alderwood gravelly sandy loam	15-30%	Low
Beausite gravelly sandy loam	15-30%	Low

- ☐ High Groundwater Table (within 5 feet)
- ☐ Other ____________
- ☐ Sole Source Aquifer
- ☐ Seeps/Springs

- ☐ Additional Sheets Attached

TECHNICAL INFORMATION REPORT (TIR) WORKSHEET

Part 11 DRAINAGE DESIGN LIMITATIONS

REFERENCE	LIMITATION / SITE CONSTRAINT
☐ Core 2 – Offsite Analysis	
☐ Sensitive/Critical Areas	
☐ SEPA	
☐ Other	
☐	

☐ Additional Sheets Attached

Part 12 TIR SUMMARY SHEET (provide one TIR Summary Sheet per Threshold Discharge Area)

Threshold Discharge Area:
(name or description) 228th Frontage Basin

Core Requirements (all 8 apply)

Discharge at Natural Location	Number of Natural Discharge Locations: 2
Offsite Analysis	Level: $\boxed{1}$ / 2 / 3 dated: 02.15.2020
Flow Control (incl. facility summary sheet)	Level: 1 / $\boxed{2}$ / 3 or Exemption Number ____________ Small Site BMPs ____________
Conveyance System	Spill containment located at: TBD
Erosion and Sediment Control	ESC Site Supervisor: TBD Contact Phone: After Hours Phone:
Maintenance and Operation	Responsibility: Private / $\boxed{\text{Public}}$ If Private, Maintenance Log Required: Yes / No
Financial Guarantees and Liability	Provided: Yes / $\boxed{\text{No}}$
Water Quality (include facility summary sheet)	Type: Basic / $\boxed{\text{Sens. Lake}}$ / Enhanced Basicm / Bog or Exemption No. ____________ Landscape Management Plan: Yes / $\boxed{\text{No}}$

Special Requirements (as applicable)

Area Specific Drainage Requirements	Type: CDA / SDO / MDP / BP / LMP / Shared Fac. / $\boxed{\text{None}}$ Name: ____________
Floodplain/Floodway Delineation	Type: Major / Minor / Exemption / $\boxed{\text{None}}$ 100-year Base Flood Elevation (or range): ____________ Datum:
Flood Protection Facilities	Describe:
Source Control (comm./industrial landuse)	Describe landuse: Describe any structural controls:

TECHNICAL INFORMATION REPORT (TIR) WORKSHEET

Oil Control	High-use Site: Yes (circled) / No Treatment BMP: OldCastle 612-2-CPS Maintenance Agreement: Yes / No (circled) with whom?
Other Drainage Structures	
Describe: Conveyance pipes, catch basins, underground detention, mechanical treatment, etc.	

Part 13 EROSION AND SEDIMENT CONTROL REQUIREMENTS

MINIMUM ESC REQUIREMENTS DURING CONSTRUCTION	MINIMUM ESC REQUIREMENTS AFTER CONSTRUCTION
☑ Clearing Limits	☑ Stabilize Exposed Surfaces
☑ Cover Measures	☑ Remove and Restore Temporary ESC Facilities
☑ Perimeter Protection	☑ Clean and Remove All Silt and Debris Ensure Operation of Permanent Facilities
☑ Traffic Area Stabilization	☐ Flag Limits of SAO and open space preservation areas
☑ Sediment Retention	☐ Other ______
☑ Surface Water Control	
☑ Dust Control	
☑ Construction Sequence	

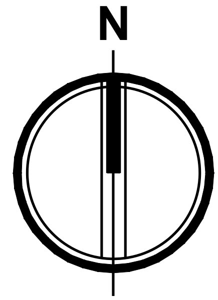
Part 14 STORMWATER FACILITY DESCRIPTIONS (Note: Include Facility Summary and Sketch)

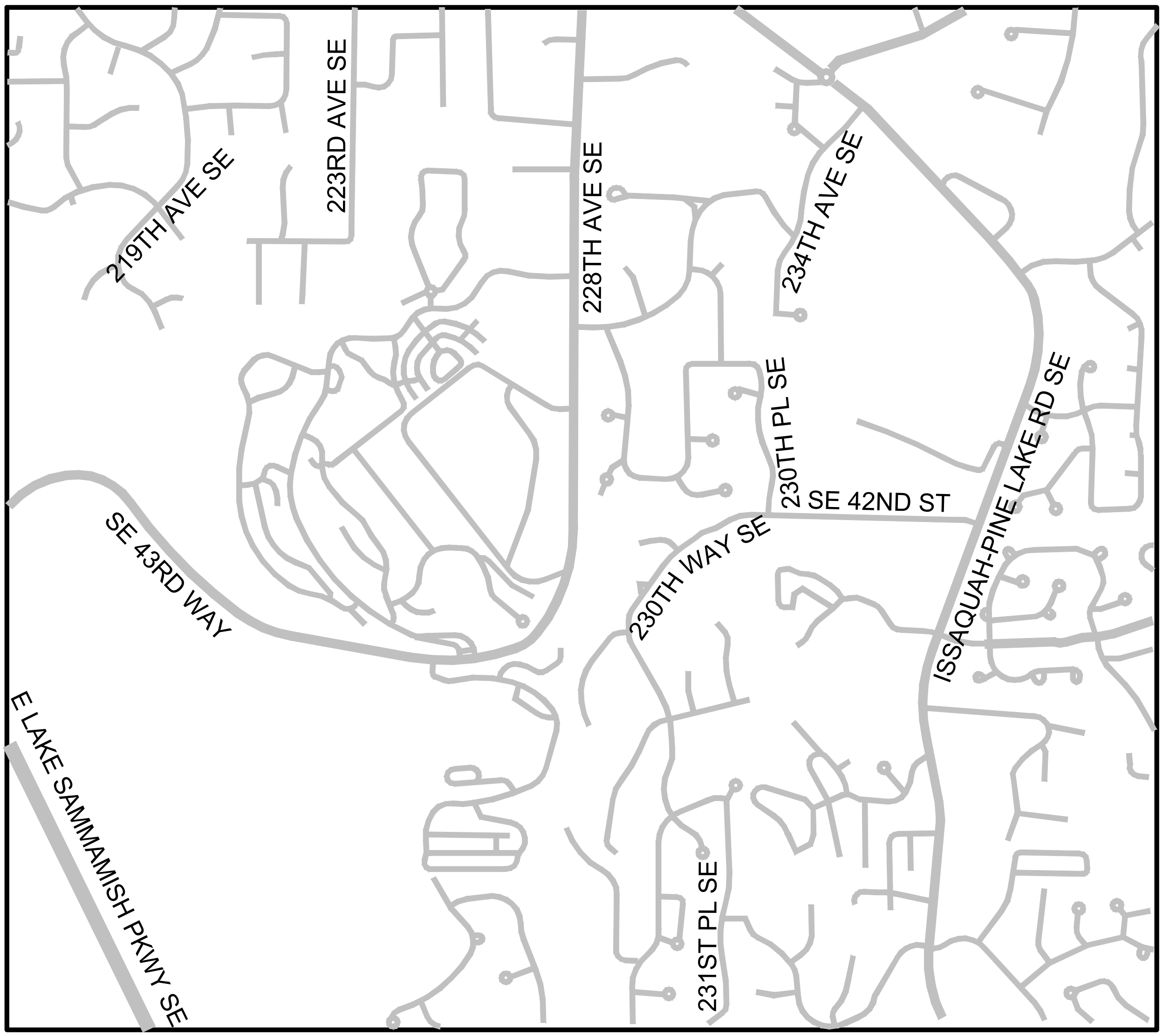
Flow Control	Type/Description	Water Quality	Type/Description
☑ Detention	0.552 ac-ft HD R-Tank	☐ Biofiltration	
☐ Infiltration		☐ Wetpool	
☐ Regional Facility		☑ Media Filtration	BioPod BPU-816-IB
☐ Shared Facility		☑ Oil Control	OldCastle 612-2-CPS
☐ Small Site BMPs		☐ Spill Control	
☐ Other		☐ Small Site BMPs	
		☐ Other	

TECHNICAL INFORMATION REPORT (TIR) WORKSHEET

Part 15 EASEMENTS/TRACTS		Part 16 STRUCTURAL ANALYSIS
❑ Drainage Easement ❑ Access Easement ❑ Native Growth Protection Covenant ❑ Tract ❑ Other		☑ Cast in Place Vault ☑ Retaining Wall ❑ Rockery > 4' High ❑ Structural on Steep Slope ❑ Other

Part 17 SIGNATURE OF PROFESSIONAL ENGINEER
I, or a civil engineer under my supervision, have visited the site. Actual site conditions as observed were incorporated into this worksheet and the attached Technical Information Report. To the best of my knowledge the information provided here is accurate. _Signed/Date_





SITE LOCATION MAP

SCALE: 1" = 1/4 MILE (1320')

AHBL
2215 North 30th Street,
Suite 300,
Tacoma, WA 98403
253.383.2422 TEL
253.383.2572 FAX

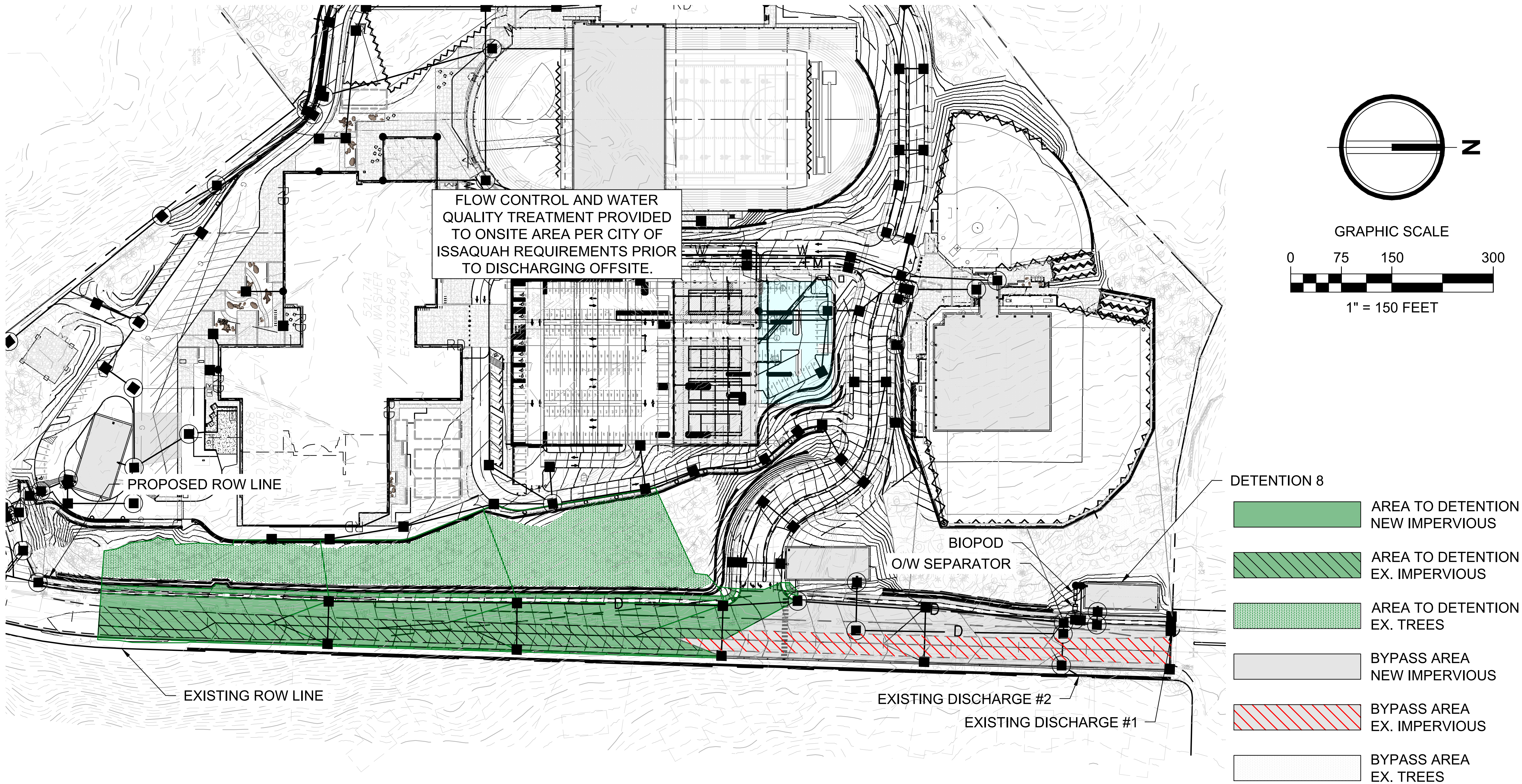
ISSAQUAH HS #4 AND ES # 17

SITE LOCATION MAP

JOB NO: 2180412.10

DATE: 02.16.21

1-2



AHBL
Civil Engineers
Structural Engineers
Landscape Architects
Community Planners
Land Surveyors
Neighbors
TACOMA · SEATTLE
2215 North 30th Street, Suite 300, Tacoma, WA 98403 253.383.2422 TEL
316 Occidental Avenue South, Suite 320, Seattle, WA 98104 206.267.2425 TEL

ISSAQUAH HIGH SCHOOL AND ELEMENTARY SCHOOL
2180412.10

PROPOSED BASIN MAP
05.19.2021

1-3

Section 2

Conditions and Requirements Summary

2.0 Conditions and Requirements Summary

2.1 Core Requirements

2.1.1 CR 1 – Discharge at the Natural Location

The existing 228th Ave SE right of way, where it fronts the Issaquah HS and ES site, flows from a high point at the south side of the proposed frontage improvements to the north through existing roadside conveyance ditches and culverts. Refer to the Drainage Basin and Site Map (Figure 1-3) for the two existing discharge locations of this portion of the roadway, Existing Discharge #1 and Existing Discharge #2. These discharge locations are maintained under existing conditions to maintain existing flows through the existing downstream City of Sammamish conveyance systems. These two discharge locations combine to make one threshold discharge area because the downstream flow path of Existing Discharge #2 travels less than ¼ mile before combining with runoff from Existing Discharge #1. Runoff from Existing Discharge #1 travels more than ¼ mile before it combines with runoff from Existing Discharge #2 but a threshold discharge area is determined using the shortest flow path (page 1-10 of the *KCSWDM*) which is the Existing Discharge #2 flow path. Runoff from the frontage threshold discharge area ultimately discharges to Laughing Jacob's Creek, downstream of Laughing Jacob's Lake. Refer to sections 2.1.2 and 3.0 for additional information on the offsite and downstream analysis performed on the frontage improvement threshold discharge area.

2.1.2 CR 2 – Offsite Analysis

The 228th Ave SE frontage improvements discharge runoff from the 228th Ave SE right-of-way to City of Sammamish stormwater conveyance easements and roadside ditches on the west side of 228th Ave SE until runoff reaches Laughing Jacob's Creek, downstream of Laughing Jacob's Lake. Existing Discharge #1 discharges runoff to an existing City of Sammamish conveyance ditch located within a 10 foot drainage easement on the west side of the roadway; this is the existing drainage path. Outlet protection is proposed at this proposed discharge location. Existing Discharge #2 discharges runoff to an existing 12 inch City of Sammamish roadside conveyance culvert; from this point runoff continues north along the existing drainage path.

Refer to Section 3 of this report for more information on the offsite analysis performed on the project site.

2.1.3 CR 3 – Flow Control

The project site is within a Conservation Flow Control (Level 2) flow control area per the City of Sammamish Flow Control Map. An R-Tank detention system is proposed on the west side of the frontage improvements to meet this flow controls standard for the proposed frontage improvements. Refer to Section 4.1 of this report for additional information on the proposed flow control facility.

2.1.4 CR 4 – Conveyance System

The proposed conveyance systems for the proposed frontage improvements are composed of underground piped flow. These conveyance systems discharge runoff near the northern limits of the frontage improvements to the existing City of Sammamish discharge locations of 228th Ave SE (Existing Discharge #1 and #2).

The proposed conveyance system will be designed using Storm and Sanitary Sewer Analysis and included in Section 5.0 of this report as part of a future final engineering submittal. This proposed conveyance system will meet all requirements for new systems outlined in Section 1.2.4.1 of the *KCSWDM*.

2.1.5 CR 5 – Construction Stormwater Pollution Prevention

A Construction Stormwater Pollution Prevention Plan (CSWPPP) shall be prepared and provided as part of a future final engineering submittal. Refer to Section 8.0 of this report for additional information.

2.1.6 CR 6 – Maintenance and Operations

Maintenance standards have been prepared for all proposed drainage structures associated with the 228th Ave SE right-of-way improvements. All stormwater facilities proposed as part of the frontage improvements will be owned and maintained by the City of Sammamish.

2.1.7 CR 7 – Financial Guarantees and Liability

The owner and contractor will obtain all necessary permits required by King County prior to the beginning of construction. The proposed frontage improvements are not subject to bonding because Issaquah School District No. 411 is a public agency; therefore, a bond quantity worksheet is not req1uired for the proposed improvements.

2.1.8 CR 8 – Water Quality

The project site is within a Sensitive Lake Treatment Area per the City of Sammamish Water Quality Map. An OldCastle BioPod system is proposed on the west side of the frontage improvements, upstream of detention, to meet this water quality standard for the proposed frontage improvements. Refer to Section 4.2 of this report for additional information of the proposed water quality facility.

2.1.9 CR 9 – Flow Control BMPs

The project site is classified as a Urban Road Improvement Project per Section 1.2.9.3 of the *KCSWDM* because the frontage improvements are a road improvement project that is within the UGA. Proposed frontage improvements must utilize the Small Road Improvement and Urban Road Improvement Projects BMPs listed below that are not found infeasible in the 228th Ave SE roadway:

1. Full dispersion is infeasible on the project site because there is not enough native vegetation within the right-of-way. Native vegetation on the west and east sides of the roadway is very steep and located on private property.

2. Fill dispersion is infeasible, as discussed above, therefore the following BMPs must be used to the maximum extent feasible:

    2.1. Full infiltration is infeasible per geotechnical recommendations. Associated Earth Sciences Inc. prepared a Subsurface Exploration, Geotechnical Hazard, and Preliminary Geotechnical Engineering Report, dated 17 September 2019 (Figure 6-1). This report states “onsite infiltration is not recommended”.

    2.2. Limited infiltration is infeasible for the same reasons as full infiltration.

    2.3. Bioretention is infeasible as a Flow Control BMP because infiltration is not recommended and a proposed bioretention would require underdrains.

    2.4. Permeable pavement is infeasible as a Flow Control BMP because infiltration is not recommended and a proposed permeable pavement would require underdrains.

3. Basic dispersion is also infeasible due to the limited amount of vegetation in the 228th Ave SE right-of-way. Vegetation on the west and east sides of the roadway is very steep and located on private property.

4. The soil moisture holding capacity of new pervious surfaces must be protected in accordance with KCC 16.82.100 (F) and (G). These KCC requirements will be met for all new pervious surfaces within the 228th Ave SE right-of-way.

2.2 Special Requirements

2.2.1 SR 1 – Other Adopted Area-Specific Requirements

To our knowledge, there are no other adopted area-specific requirements that are applicable to the 228th Ave SE right-of-way.

2.2.2 SR 2 – Flood Hazard Area Delineation

Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map No. 53033C0685 F was reviewed for this project. It indicates that the project site is within a Zone X area. This area is determined to be outside of the 500-year floodplain. See Figure 2-1 for the Flood Insurance Rate Map.

2.2.3 SR 3 – Flood Protection Facilities

The project site does not contain, nor is it adjacent to, any existing flood protection facilities. Project improvements do not include flood protection measures.

2.2.4 SR 4 – Source Controls

The proposed frontage improvements include the expansion of the existing 228th Ave SE right-of-way with new curb and gutter, additional travel and turn lanes, shoulders, a landscape strip, and a sidewalk.

The *King County Stormwater Pollution Prevention Manual (KCSPPM)* will be referenced for source control measures, in addition to erosion and sediment control measures during construction. Construction source controls will be included in the future CSWPPP, to be submitted as part of a final civil engineering submittal package. Post-construction source controls will be provided as part of the Operations and Maintenance Plan as part of a final civil engineering submittal package.

2.2.5 SR 5 – Oil Control

Heffron Transportation, Inc., the project traffic engineer, anticipates an average weekday traffic volume of 25,400 vehicles per day for the proposed intersection of the school's site access and 228th Ave SE. This average weekday traffic volume is higher than the average daily traffic (ADT) because it excludes weekends and this average weekday traffic volume assumes a 1.5% growth per year until 2024 to achieve this weekday traffic volume.

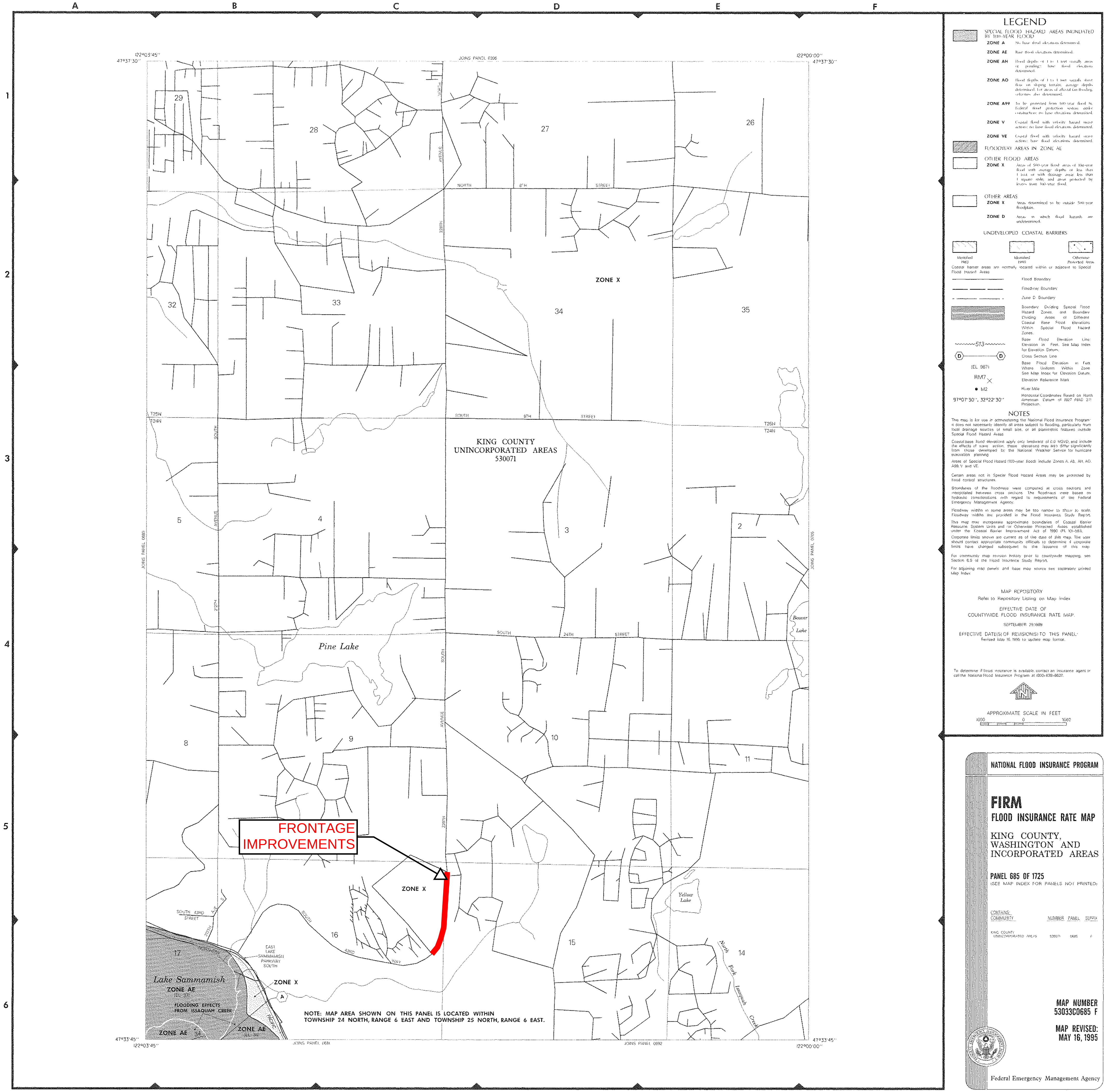
The *KCSWDM* states that a road project on an intersection subject to braking, turning, or stopping, with a measured ADT count of 25,000 vehicles or more on the main roadway is considered a high-use site therefore the High-Use menu must be applied to all runoff from the roadway portion of the proposed frontage improvements.

A coalescing plate oil/water separator is proposed on the project site per Section 6.1.5 of the *KCSWDM*, Oil control Option 3, downstream of the proposed BioPod treatment structure and upstream of the proposed R-Tank detention system.

Section 2.0 Figures

Figure 2-1
Flood Insurance Rate Map

PRJ19-00008 Attachment 054



Section 3

Offsite Analysis

3.0 Offsite Analysis

Task 1 – Define and map the study area.

The proposed 228th Ave SE right-of-way improvements front the Issaquah HS and ES project site located at 4221 228th Ave SE, Issaquah, WA 98029. The frontage improvements have to existing discharge locations, Existing Discharge #1 and #2, which are both in the same threshold discharge area and will be maintained under developed conditions. The frontage threshold discharge area is located within the East Lake Sammamish drainage basin and drains as follows:

- Existing Discharge #1 discharges from the 228th Ave SE right-of-way on the east side of the road into a City of Sammamish drainage easement between two residential properties, 4007 and 4019 229th Ave SE, Sammamish, WA 98075. This drainage easement discharges runoff east between these two residential properties until it reaches a 229th Ave SE roadside conveyance ditch and flows south along the existing roadway. Runoff then reaches a 24 inch corrugated metal culvert and crosses under 229th Ave SE to a City of Sammamish drainage easement between two residential properties, 4040 and 4106 229th Ave SE, Sammamish, WA 98075. This drainage easement conveys runoff east to the east side of these residential properties where the runoff turns north and follows the eastern edge of these residential properties until it reaches the south edge of the 22929 SE 40th St, Sammamish, WA 98075. This point is over ¼ mile downstream of the proposed frontage improvements and is the point where runoff from Existing Discharge #2 combines with runoff from Existing Discharge #1.

- Existing Discharge #2 discharges runoff north from the northern edge of the proposed frontage improvements into an existing 12” PVC culvert on the west side of the 228th Ave SE right-of-way. This culvert is part of the existing City of Sammamish 228th Ave SE conveyance system. This City of Sammamish 228th Ave SE roadside conveyance system discharges runoff north until it crosses under the 228th Ave SE roadway and discharges into a City of Sammamish drainage easement between two residential properties, 22909 SE 37th St and 3911 229th Pl SE Sammamish, WA 98075. This drainage easement discharges runoff east between residential properties until it reaches the eastern edge of a residential parcel at 3916 229th Pl SE, Sammamish, WA 98075 where it turns southeast between residential properties and discharges to an existing SE 40th St roadside conveyance ditch. This conveyance ditch conveys runoff southwest along the SE 40th St roadway until it reaches an existing 12 inch corrugated metal culvert and crosses under SE 40th St to a roadside conveyance ditch on the south side of SE 40th St. This roadside conveyance ditch discharges runoff southwest along the SE 40th St roadway until it reaches a City of Sammamish drainage easement between two residential properties, 22917 and 22929 SE 40th St, Sammamish, WA 98075. This City of Sammamish drainage easement discharges runoff south between the residential properties until it reaches the above mentioned point where runoff from Existing Discharge #1 combined with runoff from Existing Discharge #2. This drainage path is less than ¼ mile downstream of Existing Discharge #2. From this point where the two existing discharge locations combine, runoff flows east between residential properties in a City of Sammamish drainage easement to 231st Ave SE. 231st Ave SE is over ¼ mile downstream of Existing Discharge #2.

AHBL staff has performed several field inspections of the above mentioned downstream flow path to a distance of over ¼ mile downstream from the proposed frontage improvements. The existing conveyance systems downstream of the discharge points areowned and maintained in good condition by the City of Sammamish. Resource review included evaluating the drainage path all the way to Laughing Jacob’s Creek and the ultimate discharge location of Lake Sammamish.

Task 2 – Review all available information on the study area.

The following resources were reviewed to discover any existing or potential problems in the study area:

- Field inspections of the downstream flow path.
- As-built drawings: The storm drainage as-built drawings for the existing buildings were reviewed.
- Survey: AHBL performed a topographic survey of the project site. This resource was reviewed to understand the existing storm drainage system.
- City of Sammamish Storm Bandit: This resource has been reviewed to assist with the downstream analysis.

Task 3 – Field inspect the study area.

AHBL staff field inspected the threshold discharge area in February 2020.

Task 4 – Describe the drainage system and its existing and predicted drainage and water quality problems.

Under existing conditions, stormwater generated in the west side of the 228th Ave SE frontage area sheet flows off of the existing roadway to a roadside conveyance ditch and culvert system owned and maintained by the City of Sammamish on the west side of the roadway. This roadside conveyance system discharges runoff north along the roadway. Runoff generated on the east side of the 228th Ave SE frontage area sheet flows off the existing roadway to the residential properties east of the roadway. Runoff generated south of Existing Discharge #1 is tributary to Existing Discharge #1 and consists of the vast majority of the existing frontage area. Runoff generated north of Existing Discharge #1 is tributary to Existing Discharge #2 and consists of only a small portion of the existing frontage area. No water quality or flow control is proposed within the 228th Ave SE roadway for any runoff generated in the existing frontage area.

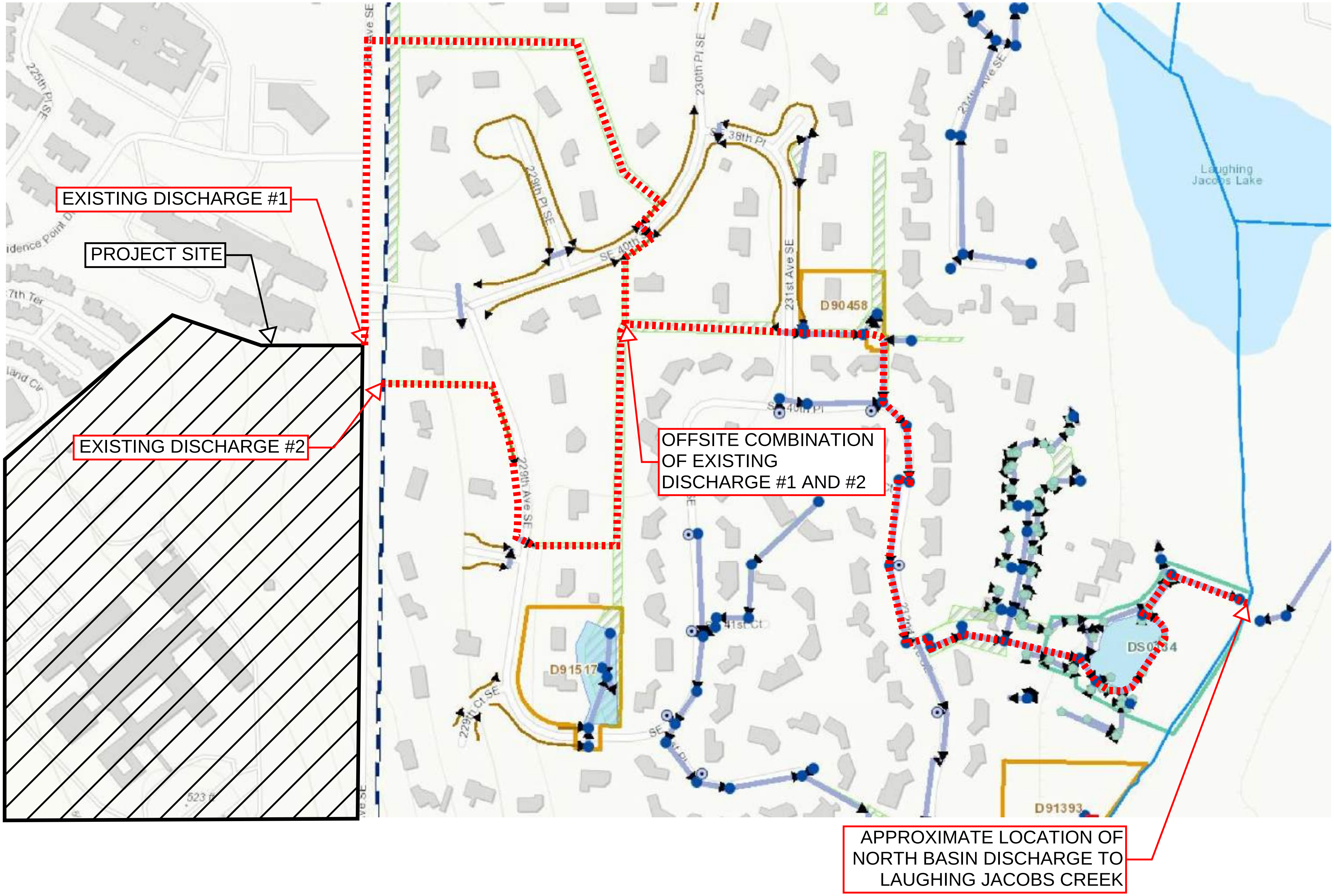
Under developed conditions, catch basins are proposed on the east and west side of the frontage improvements to capture all runoff generated in the proposed improvements. Flow control and water quality treatment are proposed for a large portion of the proposed frontage improvements; refer to Section 4.0 of this report for a discussion on how this meets the required flow control and water quality standards. Runoff will no longer flow through conveyance ditches or sheet flow off of the roadway into residential properties; this will reduce the risk of any erosion concerns to develop. The proposed water quality treatment facility will also reduce the amount of pollutants that discharge into Laughing Jacob's Creek because no existing water quality is provided within the roadway.

A downstream conveyance analysis will be provided as part of a final engineering submittal package to show that the existing downstream conveyance system has capacity to convey the proposed stormwater flows discharging from the proposed frontage improvements.

Section 3.0 Figures

Offsite Analysis Drainage System Table and Map

PRJ19-00008 Attachment 054



OFF-SITE ANALYSIS DRAINAGE SYSTEM TABLE
SURFACE WATER DESIGN MANUAL, CORE REQUIREMENT #2

Basin: Laughing Jacobs Creek **Subbasin Name:** Existing Discharge #1 **Subbasin Number:** Basin 8 (bypass only) Basin 1

Symbol	Drainage Component Type, Name, and Size	Drainage Component Description	Slope	Distance from site discharge	Existing Problems	Potential Problems	Observations of field inspector, resource reviewer, or resident
see map	Type: sheet flow, swale, stream, channel, pipe, pond; Size: diameter, surface area	drainage basin, vegetation, cover, depth, type of sensitive area, volume	%	¼ ml = 1,320 ft.	constrictions, under capacity, ponding, overtopping, flooding, habitat or organism destruction, scouring, bank sloughing, sedimentation, incision, other erosion		tributary area, likelihood of problem, overflow pathways, potential impacts
1	CONVEYANCE DITCH	228TH AVE SE ROADSIDE DITCH		800 FT	NONE	NONE	NONE
2	CONVEYANCE DITCH	DITCH WITHIN UTILITY 30' DRAINAGE EASEMENT		540 FT	NONE	NONE	NONE
3	CONVEYANCE DITCH	SE 40TH ST ROADSIDE DITCH		80 FT	NONE	NONE	NONE
4	PIPE FLOW	12" CMP PIPE	1%	44 FT	NONE	NONE	NONE
5	CONVEYANCE DITCH	SE 40TH ST ROADSIDE DITCH		80 FT	NONE	NONE	NONE
6	CONVEYANCE DITCH	DITCH WITHIN UTILITY 10' DRAINAGE EASEMENT		160 FT	NONE	NONE	NONE
7*	CONVEYANCE DITCH	DITCH WITHIN UTILITY 30' DRAINAGE EASEMENT		102 FT	NONE	NONE	NONE
				1320 FT			

* THE INTERSECTION OF POINTS 6 AND 7 IS THE LOCATION WHERE EXISTING DICHARGE #1 AND #2 COMBINE. EXISTING DICHARGE #2 MUST TRAVEL MORE THAN 1/4 MILE TO REACH THIS LOCATION BUT THE KCSWDM (PAGE 1-10) STATES THAT DISCHARGE LOCATIONS MSUT COMBINE WITHIN 1/4 MILE DOWNSTREAM OF THE SITE ON THE SHORTEST FLOWPATH. EXISTING DISCHARGE #1 REACHES THIS INTERSECITON PRIOR TO TRAVELING 1/4 MILE DOWNSTREAM.

OFF-SITE ANALYSIS DRAINAGE SYSTEM TABLE
SURFACE WATER DESIGN MANUAL, CORE REQUIREMENT #2

Basin: Laughing Jacobs Creek **Subbasin Name:** Existing Discharge #2 **Subbasin Number:** Basin 8 (detention only) Basin 2

Symbol	Drainage Component Type, Name, and Size	Drainage Component Description	Slope	Distance from site discharge	Existing Problems	Potential Problems	Observations of field inspector, resource reviewer, or resident
see map	Type: sheet flow, swale, stream, channel, pipe, pond; Size: diameter, surface area	drainage basin, vegetation, cover, depth, type of sensitive area, volume	%	¼ ml = 1,320 ft.	constrictions, under capacity, ponding, overtopping, flooding, habitat or organism destruction, scouring, bank sloughing, sedimentation, incision, other erosion		tributary area, likelihood of problem, overflow pathways, potential impacts
1	CONVEYANCE DITCH	DITCH WITHIN UTILITY 10' DRAINAGE EASEMENT		308 FT	NONE	NONE	NONE
2	CONVEYANCE DITCH	229TH AVE SE ROADSIDE DITCH		400 FT	NONE	NONE	NONE
3	PIPE FLOW	24" CMP PIPE	2%	48 FT	NONE	NONE	NONE
4	CONVEYANCE DITCH	DITCH WITHIN UTILITY 10' DRAINAGE EASEMENT		200 FT	NONE	NONE	NONE
5	CONVEYANCE DITCH	DITCH WITHIN UTILITY 23' DRAINAGE EASEMENT		364 FT	NONE	NONE	NONE
				1320 FT			

1/9/2009

Section 4

Flow Control and Water Quality Facilities Analysis and Design

4.0 Flow Control and Water Quality Facility Analysis and Design

4.1 Flow Control

The proposed 228th Ave SE frontage improvements are located within a Conservation Flow Control Area therefor proposed flows must match predeveloped durations for the range of predeveloped discharge rates from 50% of the 2-year peak flow up to the full 50-year peak flow as well as match developed peak discharge rates to predeveloped peak discharge rates for the 2- and 10-year return periods. Historic site conditions must be used as the predeveloped condition.

The existing 228th Ave SE asphalt roadway will be protected under developed conditions with only a grind and overlay proposed. This existing roadway is neither a new nor replaced impervious surface because the existing base course will not be touched as part of the proposed frontage improvements. Under the predeveloped portion of the WWHM flow control model, this existing pavement was modeled as existing road surfaces, not the historic forested condition because it is neither new nor replaced impervious area. All other areas within the Frontage Basin were modeled as forested to match the historic site condition.

Table 3 shows a comparison of the predeveloped and developed WWHM models used in the flow control analysis. The proposed frontage basin is split into two separate subbasins as part of this analysis; the detention and the bypass subbasins. The detention subbasin discharges to proposed Detention 8 while the bypass subbasin does not pass through flow control. Both subbasins were modeled with the same point of compliance to ensure that the combined developed runoff meets the conservation flow control requirement for the entire frontage basin.

Table 3. Flow Control Areas

	Pervious (ac)	Impervious (ac)	Total (ac)
Existing	**5.50**	**1.20**	**6.70**
Frontage to Detention	2.20	1.70	3.90
Frontage to Bypass	1.60	1.20	2.80
Total Frontage	**3.80**	**2.90**	**6.70**

Detention is proposed in the form of Detention 8, an ACF Environmental R-Tank detention facility. WWHM was used to size Detention 8. For WWHM flow control calculations showing the developed discharge durations meet the requirements of a Conservation Flow Control area, refer to Figure 4-1. ACF Environmental recommends that all R-Tank detention facilities have a maintenance row sized based on the water quality flow tributary to the detention facility. This maintenance row is not designed to provide any level of water quality treatment and is only provided to improve maintenance of the proposed facility; refer to Figure 4-2 for calculations showing the sizing of this maintenance row. For the exact location of Detention 8, refer to Figure 1-3.

4.2 Water Quality System

The proposed 228th Ave SE frontage improvements are located within a Sensitive Lake Protect Area and water quality facilities must be chosen using the Sensitive Lake Protection Menu found in the *KCSWDM*. An OldCastle BioPod Biofilter Underground treatment vault is proposed to provide water quality treatment to the proposed frontage improvements. These BioPod Biofilter systems are not listed in the Sensitive Lake Protection Menu however these structures have a DOE GULD for both enhanced and phosphorus treatment, see Figure 4-4. The treatment goal of the lake protection menu is to achieve a goal of 50 percent total phosphorus removal in addition basic treatment. The DOE GULD states that the proposed BioPod Biofilter system provides removal of:

- 80% of total suspended solids for influent concentrations greater than 100 mg/L and achieve a 20 mg/L effluent for influent concentrations less than 100 mg/L.
- 60% dissolved zinc for influent concentrations 0.02 to 0.3 mg/L.
- 30% dissolved copper for influent concentrations 0.005 to 0.02 mg/L.
- 50% or greater total phosphorus for influent concentrations 0.1 to 0.5 mg/L.

Based on the testing referenced in the DOE GULD, the proposed BioPod Biofilter system meets the treatment goal of the Sensitive Lake Protection Menu.

As mentioned in Section 4.1 of this report, a large amount of the existing pollution generating asphalt within the Frontage Basin will be protected as part of the proposed improvements therefore these areas are not new nor replaced impervious surfaces. Water quality treatment is not required for this existing asphalt because it is neither new nor replaced. Also mentioned in Section 4.1, the proposed Frontage Basin has been split into detention and bypass subbasins. The detention basin will pass through the proposed BioPod Biofilter system prior to discharging to the proposed flow control facility. The bypass basin discharges downstream with no flow control or water quality provided. A treatment trade is proposed where the existing asphalt pavement located within the detention subbasin will discharge to the proposed treatment structure while the new pollution generating surfaces proposed within the bypass basin will bypass treatment. Table 4 shows a breakdown of the existing and proposed pollution generating areas found in each of the Frontage Basin subbasins to show that the amount of existing pollution generating area discharging to treatment matches the amount of new/replaced pollution generating area that bypasses treatment.

Table 4. Pollution Generating Area

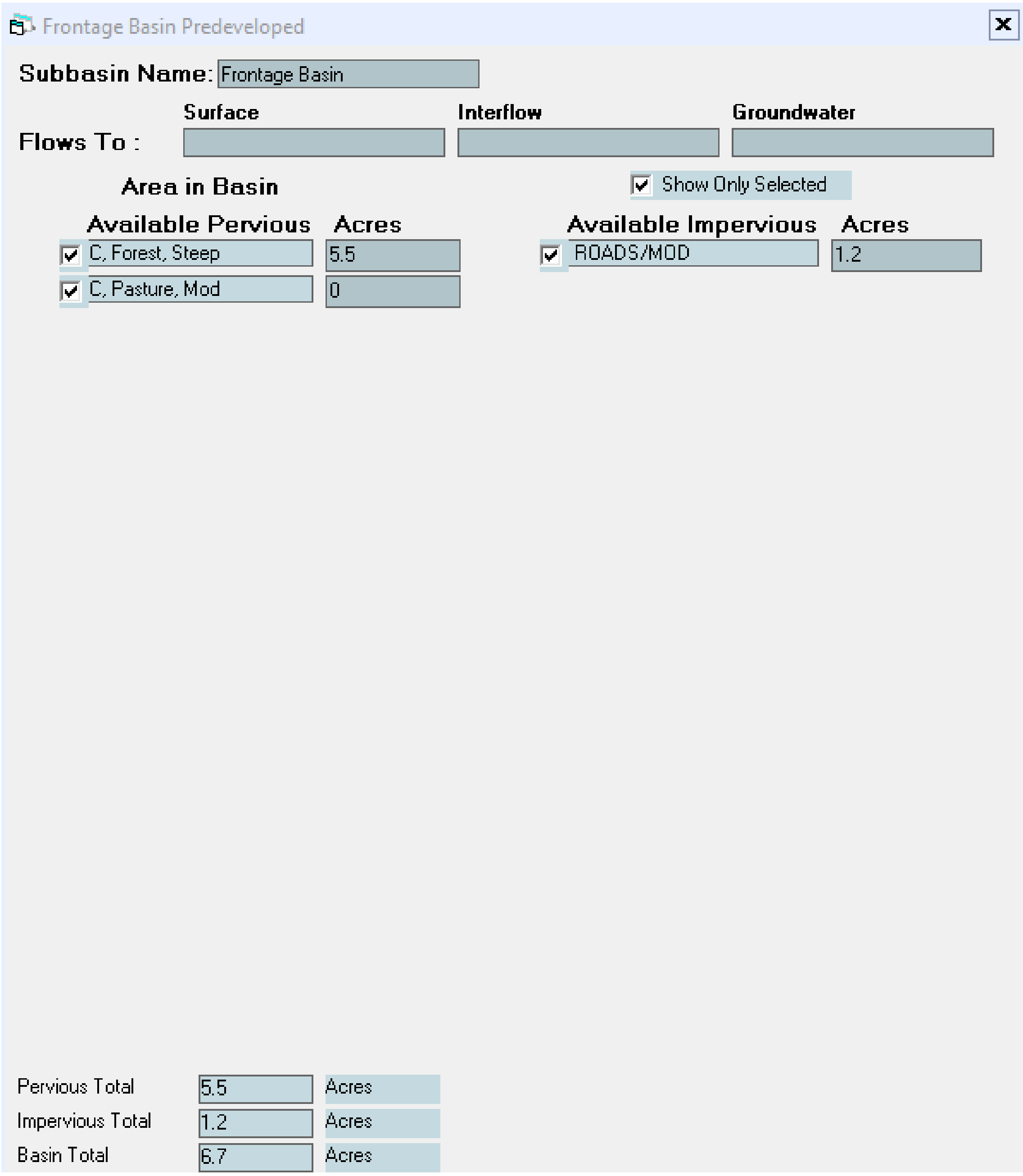
	Proposed (ac)	Existing (ac)	Total (ac)
Frontage to Detention	1.00	0.70	1.70
Frontage to Bypass	0.70	0.51	1.21

Table 4 shows that 0.70 acres of existing pollution generating roadway will discharge to the proposed treatment facility while 0.70 acres of new/replaced pollution generating roadway will bypass treatment.

Refer to Figure 4-2 for WWHM Water Quality Treatment Calculations showing that the proposed BioPod Biofilter system has adequate treatment capacity to provide Sensitive Lake Protection water quality treatment per the DOE GULD.

Section 4.0 Figures

Predeveloped Frontage Basin

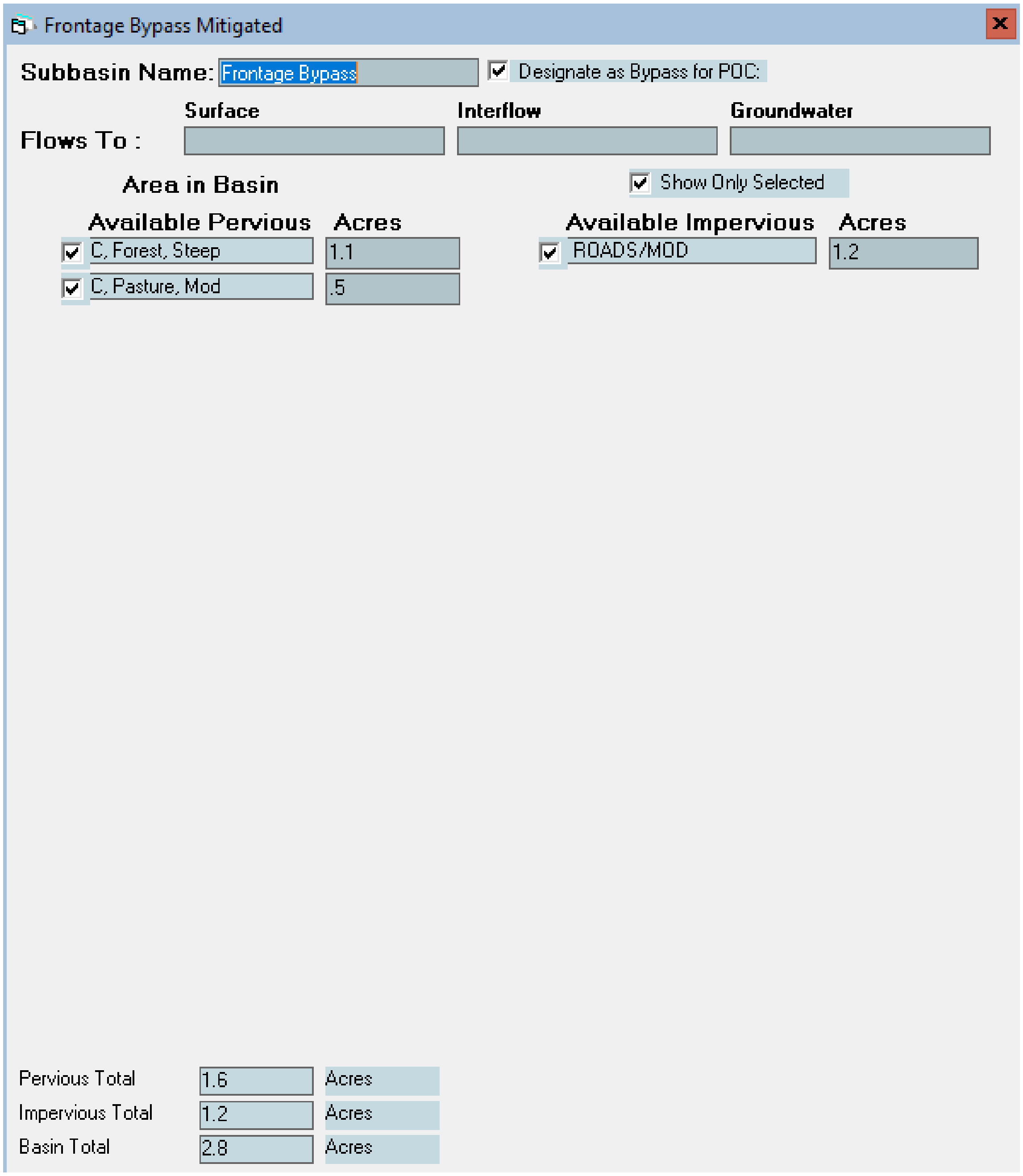


The 228th Avenue Southeast Frontage Basin, under existing conditions, is comprised of the existing 228th Avenue Southeast roadway and a portion of forested area on the west side of the project site. The existing 228th Avenue Southeast conveyance system is the existing downstream discharge location of the above mentioned onsite vegetated areas. 229th Avenue Southeast is an existing roadway with pollution generating asphalt pavement. This existing asphalt pavement is going to be protected, as shown on the civil plans, with only maintenance activities proposed on this pavement. This existing pavement is included in the WWHM flow control model as impervious roadway in the developed condition because it is neither new nor replaced surfacing but an existing hard surface.

PRJ19-00008 Attachment 054

Developed Frontage Basin

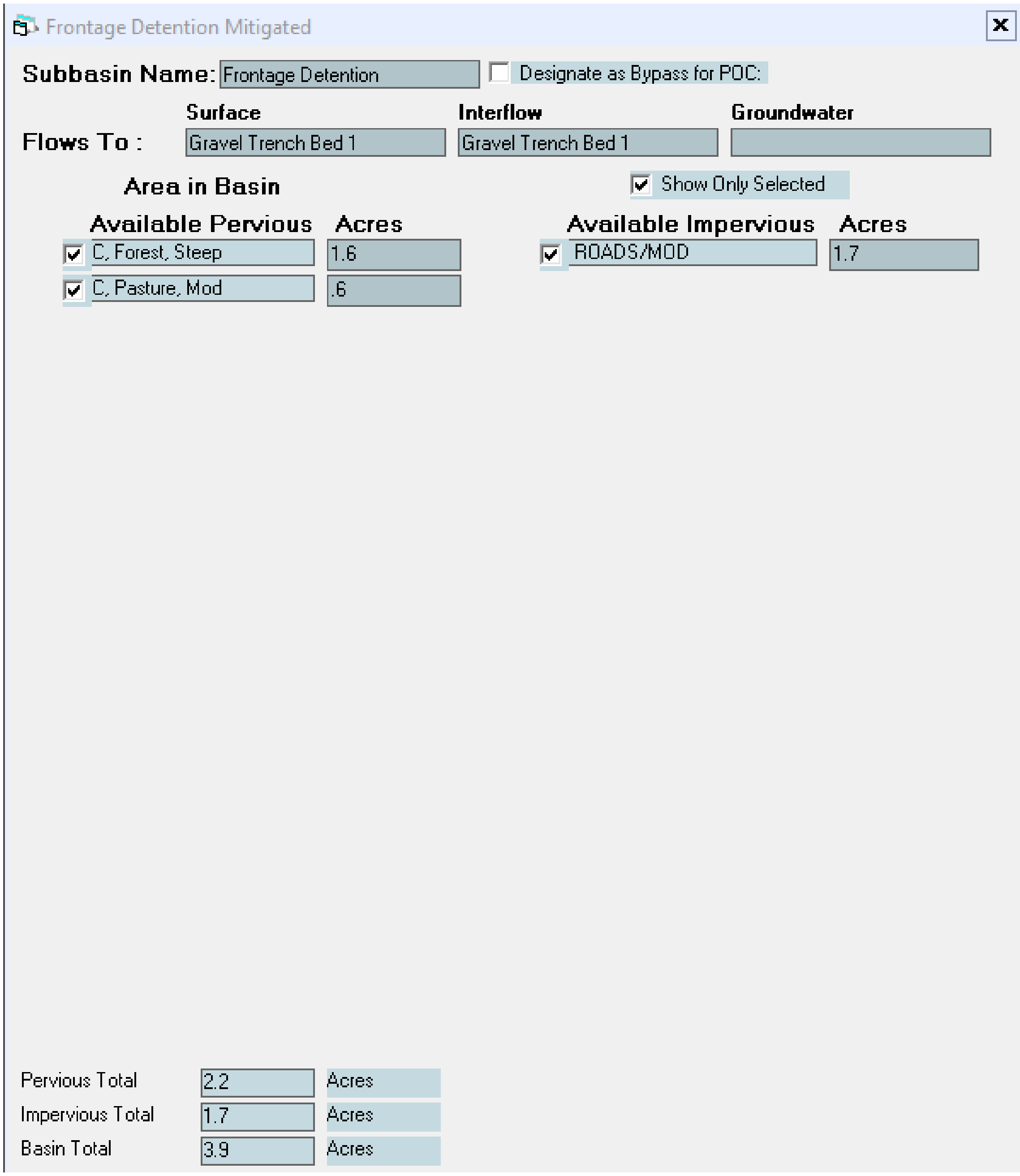
Frontage to Bypass



This portion of the Frontage Basin does not pass through proposed water quality of flow control facilities. The WWHM flow control model was set up to model this portion of the Frontage Basin as discharging directly to the POC without flow control being provided while the rest of the Frontage Basin, discussed below, discharges to the Detention 8 for flow control prior to discharging downstream. Refer to Figure 1-3 for existing and proposed basin maps.

PRJ19-00008 Attachment 054

Frontage to Treatment and Detention


Frontage Detention Mitigated

Subbasin Name: Frontage Detention
Designate as Bypass for POC:

	Surface	Interflow	Groundwater
Flows To :	Gravel Trench Bed 1	Gravel Trench Bed 1	

Area in Basin
Show Only Selected

Available Pervious	Acres
C, Forest, Steep	1.6
C, Pasture, Mod	.6

Available Impervious	Acres
ROADS/MOD	1.7

Pervious Total	2.2	Acres
Impervious Total	1.7	Acres
Basin Total	3.9	Acres

This portion of the Frontage Basin discharges through both water quality treatment as well as Detention 8 for flow control prior do discharging downstream. Refer to Figure 1-3 for existing and proposed basin maps. Refer to Figure 4-2 for WWHM water quality calculations.

Detention 8

Gravel Trench Bed 1 Mitigated

Facility Name	Gravel Trench Bed 1		
	Outlet 1	**Outlet 2**	**Outlet 3**
Downstream Connection	0	0	0
Facility Type	Gravel Trench/Bed		

☐ Precipitation Applied to Facility

☐ Evaporation Applied to Facility

Quick Trench

Facility Dimension Diagram

Facility Dimensions

Trench Length (ft)	67
Trench Bottom Width (ft)	67
Effective Total Depth (ft)	6.73
Top and bottom slope (H/V)	0
Left Side Slope (H/V)	0
Right Side Slope (H/V)	0

Outlet Structure Data

Riser Height (ft)	6.23
Riser Diameter (in)	18
Riser Type	Flat
Notch Type	

Material Layers for Trench/Bed

Layer 1 Thickness (ft)	0.25
Layer 1 porosity (0-1)	0.4
Layer 2 Thickness (ft)	6.3
Layer 2 porosity (0-1)	0.9
Layer 3 Thickness (ft)	0.18
Layer 3 porosity (0-1)	0.4

Orifice Number	Diameter (in)	Height (ft)
1	2.125	0.5
2	5.875	5.74
3	0	0

Trench Volume at Riser Head (ac-ft) .571

Infiltration NO

These calculations show that 5.73’ of live storage is provided on top of 6” of dead storage and with 6” of freeboard. Freeboard is provided with the bottom 0.18’ of the 12” top gravel section plus the top 0.32’ of the tank section, totaling 6” of freeboard storage at the top of live storage. Dead storage is provided by the bottom 3” of the detention tanks as well as the 3” of gravel below the proposed tanks, totaling 6” of dead storage at the bottom of the detention system.

ACF Environmental HD R-Tanks shall be used for Detention 8. The manufacturer states that a porosity of 0.95 should be used for the R-Tank section; a porosity of 0.9 was used as a conservative design. A porosity of 0.4 was used for the top gravel layer.

WWHM2012

PROJECT REPORT

General Model Information

Project Name:	Frontage Basin
Site Name:	
Site Address:	
City:	
Report Date:	3/5/2021
Gage:	Seatac
Data Start:	1948/10/01
Data End:	2009/09/30
Timestep:	15 Minute
Precip Scale:	1.167
Version Date:	2019/09/13
Version:	4.2.17

POC Thresholds

Low Flow Threshold for POC1:	50 Percent of the 2 Year
High Flow Threshold for POC1:	50 Year

Landuse Basin Data

Predeveloped Land Use

Frontage Basin

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Forest, Steep	5.5
Pervious Total	5.5
Impervious Land Use	acre
ROADS MOD	1.2
Impervious Total	1.2
Basin Total	6.7

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

Frontage Bypass

Bypass:	Yes
GroundWater:	No
Pervious Land Use	acre
C, Forest, Steep	1.1
C, Pasture, Mod	0.5
Pervious Total	1.6
Impervious Land Use	acre
ROADS MOD	1.2
Impervious Total	1.2
Basin Total	2.8

Element Flows To:

Surface	Interflow	Groundwater

Frontage Detention

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Pasture, Mod	0.6
C, Forest, Steep	1.6
Pervious Total	2.2
Impervious Land Use	acre
ROADS MOD	1.7
Impervious Total	1.7
Basin Total	3.9

Element Flows To:

Surface	Interflow	Groundwater
Gravel Trench Bed 1	Gravel Trench Bed 1	

Figure 4-1

Routing Elements

Predeveloped Routing

Mitigated Routing

Gravel Trench Bed 1

Bottom Length: 67.00 ft.
Bottom Width: 67.00 ft.
Trench bottom slope 1: 0 To 1
Trench Left side slope 0: 0 To 1
Trench right side slope 2: 0 To 1
Material thickness of first layer: 0.25
Pour Space of material for first layer: 0.4
Material thickness of second layer: 6.3
Pour Space of material for second layer: 0.9
Material thickness of third layer: 0.18
Pour Space of material for third layer: 0.4
Discharge Structure
Riser Height: 6.23 ft.
Riser Diameter: 18 in.
Orifice 1 Diameter: 2.125 in. Elevation:0.5 ft.
Orifice 2 Diameter: 5.875 in. Elevation:5.74 ft.
Element Flows To:
Outlet 1 Outlet 2

Gravel Trench Bed Hydraulic Table

Stage(feet)	**Area(ac.)**	**Volume(ac-ft.)**	**Discharge(cfs)**	**Infilt(cfs)**
0.0000	0.103	0.000	0.000	0.000
0.0748	0.103	0.003	0.000	0.000
0.1496	0.103	0.006	0.000	0.000
0.2243	0.103	0.009	0.000	0.000
0.2991	0.103	0.016	0.000	0.000
0.3739	0.103	0.023	0.000	0.000
0.4487	0.103	0.030	0.000	0.000
0.5234	0.103	0.037	0.018	0.000
0.5982	0.103	0.043	0.038	0.000
0.6730	0.103	0.050	0.051	0.000
0.7478	0.103	0.057	0.061	0.000
0.8226	0.103	0.064	0.069	0.000
0.8973	0.103	0.071	0.077	0.000
0.9721	0.103	0.078	0.084	0.000
1.0469	0.103	0.085	0.090	0.000
1.1217	0.103	0.092	0.096	0.000
1.1964	0.103	0.099	0.102	0.000
1.2712	0.103	0.106	0.107	0.000
1.3460	0.103	0.113	0.112	0.000
1.4208	0.103	0.120	0.117	0.000
1.4956	0.103	0.127	0.122	0.000
1.5703	0.103	0.134	0.126	0.000
1.6451	0.103	0.141	0.131	0.000
1.7199	0.103	0.148	0.135	0.000
1.7947	0.103	0.154	0.139	0.000
1.8694	0.103	0.161	0.143	0.000
1.9442	0.103	0.168	0.147	0.000
2.0190	0.103	0.175	0.151	0.000
2.0938	0.103	0.182	0.154	0.000
2.1686	0.103	0.189	0.158	0.000
2.2433	0.103	0.196	0.161	0.000

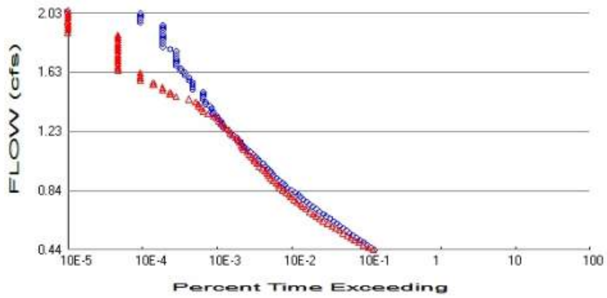
2.3181	0.103	0.203	0.165	0.000
2.3929	0.103	0.210	0.168	0.000
2.4677	0.103	0.217	0.171	0.000
2.5424	0.103	0.224	0.175	0.000
2.6172	0.103	0.231	0.178	0.000
2.6920	0.103	0.238	0.181	0.000
2.7668	0.103	0.245	0.184	0.000
2.8416	0.103	0.252	0.187	0.000
2.9163	0.103	0.258	0.190	0.000
2.9911	0.103	0.265	0.193	0.000
3.0659	0.103	0.272	0.196	0.000
3.1407	0.103	0.279	0.199	0.000
3.2154	0.103	0.286	0.201	0.000
3.2902	0.103	0.293	0.204	0.000
3.3650	0.103	0.300	0.207	0.000
3.4398	0.103	0.307	0.210	0.000
3.5146	0.103	0.314	0.212	0.000
3.5893	0.103	0.321	0.215	0.000
3.6641	0.103	0.328	0.218	0.000
3.7389	0.103	0.335	0.220	0.000
3.8137	0.103	0.342	0.223	0.000
3.8884	0.103	0.349	0.225	0.000
3.9632	0.103	0.356	0.228	0.000
4.0380	0.103	0.363	0.230	0.000
4.1128	0.103	0.369	0.232	0.000
4.1876	0.103	0.376	0.235	0.000
4.2623	0.103	0.383	0.237	0.000
4.3371	0.103	0.390	0.240	0.000
4.4119	0.103	0.397	0.242	0.000
4.4867	0.103	0.404	0.244	0.000
4.5614	0.103	0.411	0.247	0.000
4.6362	0.103	0.418	0.249	0.000
4.7110	0.103	0.425	0.251	0.000
4.7858	0.103	0.432	0.253	0.000
4.8606	0.103	0.439	0.255	0.000
4.9353	0.103	0.446	0.258	0.000
5.0101	0.103	0.453	0.260	0.000
5.0849	0.103	0.460	0.262	0.000
5.1597	0.103	0.467	0.264	0.000
5.2344	0.103	0.473	0.266	0.000
5.3092	0.103	0.480	0.268	0.000
5.3840	0.103	0.487	0.270	0.000
5.4588	0.103	0.494	0.272	0.000
5.5336	0.103	0.501	0.274	0.000
5.6083	0.103	0.508	0.277	0.000
5.6831	0.103	0.515	0.279	0.000
5.7579	0.103	0.522	0.406	0.000
5.8327	0.103	0.529	0.568	0.000
5.9074	0.103	0.536	0.668	0.000
5.9822	0.103	0.543	0.747	0.000
6.0570	0.103	0.550	0.816	0.000
6.1318	0.103	0.557	0.877	0.000
6.2066	0.103	0.564	0.932	0.000
6.2813	0.103	0.571	1.168	0.000
6.3561	0.103	0.578	1.741	0.000
6.4309	0.103	0.584	2.490	0.000
6.5057	0.103	0.591	3.344	0.000
6.5804	0.103	0.594	4.238	0.000

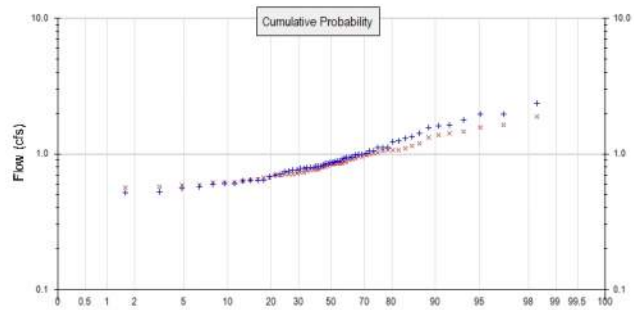
6.6552	0.103	0.598	5.103	0.000
6.7300	0.103	0.601	5.876	0.000

Figure 4-1

Analysis Results

POC 1





+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 5.5
Total Impervious Area: 1.2

Mitigated Landuse Totals for POC #1
Total Pervious Area: 3.8
Total Impervious Area: 2.9

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	0.87832
5 year	1.199902
10 year	1.436823
25 year	1.764639
50 year	2.030282
100 year	2.314962

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	0.836096
5 year	1.078287
10 year	1.248947
25 year	1.47679
50 year	1.655678
100 year	1.842648

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1949	1.233	1.055
1950	1.118	0.958
1951	0.891	0.986
1952	0.601	0.585
1953	0.500	0.613
1954	0.704	0.670
1955	0.780	0.709
1956	0.818	0.710
1957	0.935	0.854
1958	0.641	0.648

1959	0.594	0.636
1960	1.049	0.946
1961	0.752	0.723
1962	0.527	0.573
1963	0.761	0.714
1964	0.790	0.725
1965	0.887	0.802
1966	0.644	0.627
1967	1.296	1.069
1968	0.985	1.099
1969	0.788	0.767
1970	0.828	0.788
1971	0.910	0.873
1972	0.993	0.874
1973	0.557	0.540
1974	0.923	0.841
1975	1.011	0.900
1976	0.814	0.762
1977	0.630	0.614
1978	0.850	0.843
1979	0.934	1.013
1980	1.784	1.377
1981	0.812	0.806
1982	1.340	1.202
1983	0.862	0.855
1984	0.608	0.585
1985	0.675	0.749
1986	0.998	0.855
1987	0.946	0.909
1988	0.569	0.612
1989	0.874	0.932
1990	2.369	1.628
1991	1.608	1.316
1992	0.754	0.701
1993	0.643	0.671
1994	0.521	0.561
1995	0.701	0.695
1996	1.414	1.147
1997	1.053	1.066
1998	0.849	0.818
1999	1.568	1.427
2000	0.796	0.755
2001	0.734	0.849
2002	1.109	1.060
2003	1.252	1.026
2004	1.634	1.568
2005	0.858	0.764
2006	0.779	0.704
2007	1.955	1.467
2008	1.956	1.888
2009	1.108	0.993

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	2.3686	1.8877
2	1.9557	1.6285
3	1.9547	1.5679

4	1.7838	1.4665
5	1.6337	1.4267
6	1.6079	1.3774
7	1.5684	1.3157
8	1.4144	1.2020
9	1.3399	1.1474
10	1.2955	1.0992
11	1.2515	1.0693
12	1.2331	1.0662
13	1.1177	1.0600
14	1.1087	1.0546
15	1.1080	1.0256
16	1.0527	1.0126
17	1.0493	0.9933
18	1.0109	0.9862
19	0.9975	0.9580
20	0.9934	0.9463
21	0.9848	0.9323
22	0.9459	0.9090
23	0.9351	0.9002
24	0.9335	0.8737
25	0.9229	0.8732
26	0.9097	0.8551
27	0.8910	0.8550
28	0.8867	0.8544
29	0.8738	0.8492
30	0.8623	0.8425
31	0.8585	0.8412
32	0.8495	0.8176
33	0.8486	0.8059
34	0.8284	0.8022
35	0.8177	0.7879
36	0.8136	0.7666
37	0.8119	0.7642
38	0.7963	0.7621
39	0.7895	0.7553
40	0.7878	0.7486
41	0.7797	0.7254
42	0.7789	0.7232
43	0.7613	0.7144
44	0.7536	0.7098
45	0.7520	0.7086
46	0.7337	0.7035
47	0.7041	0.7005
48	0.7006	0.6951
49	0.6749	0.6706
50	0.6435	0.6695
51	0.6433	0.6477
52	0.6408	0.6363
53	0.6296	0.6270
54	0.6082	0.6143
55	0.6005	0.6125
56	0.5940	0.6118
57	0.5688	0.5855
58	0.5569	0.5846
59	0.5265	0.5733
60	0.5206	0.5614
61	0.5003	0.5397

Figure 4-1

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.4392	2751	2642	96	Pass
0.4552	2462	2295	93	Pass
0.4713	2212	1984	89	Pass
0.4874	1969	1697	86	Pass
0.5034	1764	1505	85	Pass
0.5195	1566	1334	85	Pass
0.5356	1397	1189	85	Pass
0.5517	1275	1047	82	Pass
0.5677	1159	931	80	Pass
0.5838	1048	836	79	Pass
0.5999	949	740	77	Pass
0.6160	864	655	75	Pass
0.6320	777	566	72	Pass
0.6481	701	502	71	Pass
0.6642	621	453	72	Pass
0.6802	569	410	72	Pass
0.6963	506	377	74	Pass
0.7124	451	332	73	Pass
0.7285	410	299	72	Pass
0.7445	372	283	76	Pass
0.7606	338	251	74	Pass
0.7767	304	232	76	Pass
0.7927	283	210	74	Pass
0.8088	264	197	74	Pass
0.8249	239	178	74	Pass
0.8410	211	163	77	Pass
0.8570	184	146	79	Pass
0.8731	172	143	83	Pass
0.8892	161	132	81	Pass
0.9052	147	120	81	Pass
0.9213	135	111	82	Pass
0.9374	120	105	87	Pass
0.9535	115	100	86	Pass
0.9695	110	93	84	Pass
0.9856	104	87	83	Pass
1.0017	97	78	80	Pass
1.0177	88	74	84	Pass
1.0338	79	68	86	Pass
1.0499	76	66	86	Pass
1.0660	71	62	87	Pass
1.0820	65	57	87	Pass
1.0981	59	54	91	Pass
1.1142	54	48	88	Pass
1.1303	49	46	93	Pass
1.1463	47	45	95	Pass
1.1624	44	42	95	Pass
1.1785	40	41	102	Pass
1.1945	39	38	97	Pass
1.2106	35	34	97	Pass
1.2267	33	32	96	Pass
1.2428	30	31	103	Pass
1.2588	26	28	107	Pass
1.2749	25	27	108	Pass

1.2910	25	24	96	Pass
1.3070	24	23	95	Pass
1.3231	22	21	95	Pass
1.3392	21	19	90	Pass
1.3553	19	16	84	Pass
1.3713	19	14	73	Pass
1.3874	18	13	72	Pass
1.4035	17	12	70	Pass
1.4195	15	12	80	Pass
1.4356	15	11	73	Pass
1.4517	14	9	64	Pass
1.4678	14	6	42	Pass
1.4838	14	5	35	Pass
1.4999	14	5	35	Pass
1.5160	10	4	40	Pass
1.5321	10	4	40	Pass
1.5481	10	3	30	Pass
1.5642	10	3	30	Pass
1.5803	9	2	22	Pass
1.5963	9	2	22	Pass
1.6124	8	2	25	Pass
1.6285	8	2	25	Pass
1.6446	7	1	14	Pass
1.6606	7	1	14	Pass
1.6767	6	1	16	Pass
1.6928	6	1	16	Pass
1.7088	6	1	16	Pass
1.7249	6	1	16	Pass
1.7410	6	1	16	Pass
1.7571	6	1	16	Pass
1.7731	6	1	16	Pass
1.7892	5	1	20	Pass
1.8053	4	1	25	Pass
1.8213	4	1	25	Pass
1.8374	4	1	25	Pass
1.8535	4	1	25	Pass
1.8696	4	1	25	Pass
1.8856	4	1	25	Pass
1.9017	4	0	0	Pass
1.9178	4	0	0	Pass
1.9339	4	0	0	Pass
1.9499	4	0	0	Pass
1.9660	2	0	0	Pass
1.9821	2	0	0	Pass
1.9981	2	0	0	Pass
2.0142	2	0	0	Pass
2.0303	2	0	0	Pass

Water Quality

Water Quality BMP Flow and Volume for POC #1

On-line facility volume:	0 acre-feet
On-line facility target flow:	0 cfs.
Adjusted for 15 min:	0 cfs.
Off-line facility target flow:	0 cfs.
Adjusted for 15 min:	0 cfs.

Figure 4-1

LID Report

LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment
Gravel Trench Bed 1 POC	☐	430.64			☐	0.00			
Total Volume Infiltrated		430.64	0.00	0.00		0.00	0.00	0%	No Treat. Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Failed

Model Default Modifications

Total of 0 changes have been made.

PERLND Changes

No PERLND changes have been made.

IMPLND Changes

No IMPLND changes have been made.

Figure 4-1

Appendix

Predeveloped Schematic

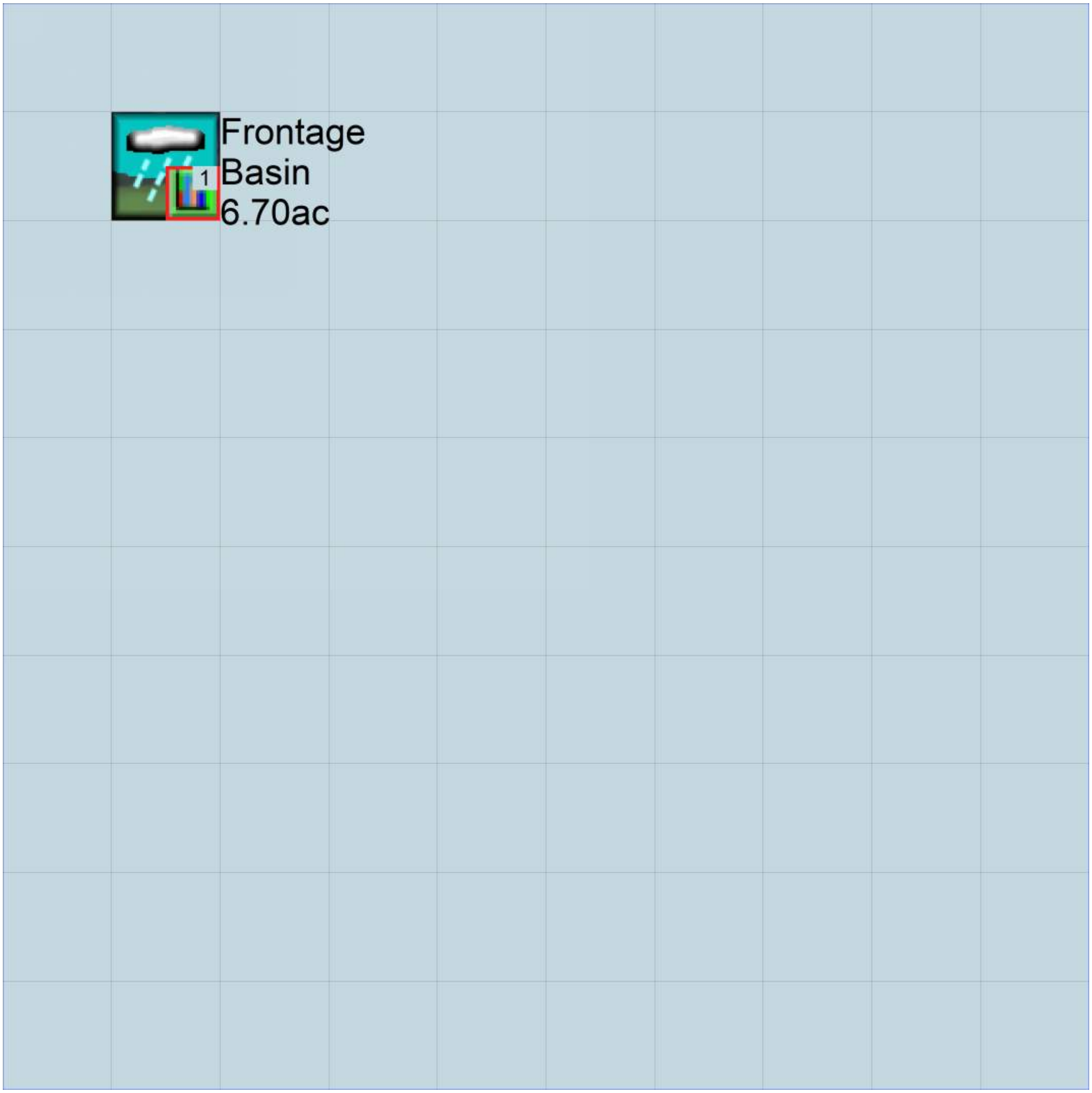


Figure 4-1

Mitigated Schematic

Predeveloped UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1948 10 01        END    2009 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN      1                   UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                             ***
WDM        26   Frontage Basin.wdm
MESSU      25   PreFrontage Basin.MES
           27   PreFrontage Basin.L61
           28   PreFrontage Basin.L62
           30   POCFrontage Basin1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      12
      IMPLND       2
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Frontage Basin              MAX                     1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                            User  t-series Engl Metr ***
                                             in  out           ***
   12      C, Forest, Steep        1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   12         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ***************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
   12         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO
```

```
  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
   12         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
   12              0       4.5      0.08       400      0.15       0.5     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   12              0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                               ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   12            0.2       0.3      0.35         6       0.3       0.7
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
               ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
   12              0         0         0         0       2.5         1         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name-------->   Unit-systems   Printer ***
    # -  #                      User  t-series Engl Metr ***
                                        in  out          ***
    2      ROADS/MOD               1     1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    2         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    2         0    0    4    0    0    0    1    9
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
    2         0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    2            400      0.05       0.1      0.08
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    2              0         0
```

```
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    2              0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Frontage Basin***
PERLND  12                         5.5     COPY   501     12
PERLND  12                         5.5     COPY   501     13
IMPLND   2                         1.2     COPY   501     15

******Routing******
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1



<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                 ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG            ***
                                           in  out                           ***
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ******************* PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                      ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *    *  *  *  *  *       *  *  *  *  *        ***
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                         ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit        for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
```

```
END SPEC-ACTIONS
FTABLES
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC      ENGL    1.167          PERLND   1 999 EXTNL  PREC
WDM      2 PREC      ENGL    1.167          IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP      ENGL    0.76           PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP      ENGL    0.76           IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
COPY   501 OUTPUT MEAN   1 1     48.4       WDM    501 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   13

  MASS-LINK       15
IMPLND     IWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   15


END MASS-LINK

END RUN
```

Mitigated UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1948 10 01        END    2009 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                   UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                             ***
WDM        26   Frontage Basin.wdm
MESSU      25   MitFrontage Basin.MES
           27   MitFrontage Basin.L61
           28   MitFrontage Basin.L62
           30   POCFrontage Basin1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      12
      PERLND      14
      IMPLND       2
      RCHRES       1
      COPY         1
      COPY       501
      COPY       601
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Gravel Trench Bed 1         MAX                     1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  601         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                          in  out           ***
   12      C, Forest, Steep        1    1    1    1   27    0
   14      C, Pasture, Mod         1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   12         0    0    1    0    0    0    0    0    0    0    0    0
   14         0    0    1    0    0    0    0    0    0    0    0    0
```

```
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ***************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
   12         0    0    4    0    0    0    0    0    0    0    0    0    1    9
   14         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
   12         0    0    0    0    0    0    0    0    0    0    0
   14         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
   12              0       4.5      0.08       400      0.15       0.5     0.996
   14              0       4.5      0.06       400       0.1       0.5     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   12              0         0         2         2         0         0         0
   14              0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                               ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   12            0.2       0.3      0.35         6       0.3       0.7
   14           0.15       0.4       0.3         6       0.5       0.4
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
              ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
   12              0         0         0         0       2.5         1         0
   14              0         0         0         0       2.5         1         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                       in  out           ***
    2      ROADS/MOD              1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    2         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    2         0    0    4    0    0    0    1    9
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
```

```
    2          0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    2            400      0.05       0.1      0.08
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    2              0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    2              0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Frontage Detention***
PERLND  14                         0.6     RCHRES   1      2
PERLND  14                         0.6     RCHRES   1      3
PERLND  12                         1.6     RCHRES   1      2
PERLND  12                         1.6     RCHRES   1      3
IMPLND   2                         1.7     RCHRES   1      5
Frontage Bypass***
PERLND  12                         1.1     COPY   501     12
PERLND  12                         1.1     COPY   601     12
PERLND  12                         1.1     COPY   501     13
PERLND  12                         1.1     COPY   601     13
PERLND  14                         0.5     COPY   501     12
PERLND  14                         0.5     COPY   601     12
PERLND  14                         0.5     COPY   501     13
PERLND  14                         0.5     COPY   601     13
IMPLND   2                         1.2     COPY   501     15
IMPLND   2                         1.2     COPY   601     15

******Routing******
PERLND  14                         0.6     COPY     1     12
PERLND  12                         1.6     COPY     1     12
IMPLND   2                         1.7     COPY     1     15
PERLND  14                         0.6     COPY     1     13
PERLND  12                         1.6     COPY     1     13
RCHRES   1                           1     COPY   501     16
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1



<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                 ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG            ***
                                          in  out                            ***
    1     Gravel Trench Be-026    1    1    1    1   28    0    1
```

```
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
    1         1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ******************* PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
    1         4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                     ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *    *  *  *  *  *        *  *  *  *  *         ***
    1        0  1  0  0    4  0  0  0  0        0  0  0  0  0       2  2  2  2  2
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
    1             1      0.01       0.0       0.0       0.5       0.0
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                        ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit        for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
    1           0         4.0  0.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
  FTABLE      1
   92    4
     Depth      Area    Volume  Outflow1 Velocity  Travel Time***
      (ft)   (acres) (acre-ft)    (cfs)  (ft/sec)    (Minutes)***
  0.000000  0.103053  0.000000  0.000000
  0.074778  0.103053  0.003082  0.000000
  0.149556  0.103053  0.006165  0.000000
  0.224333  0.103053  0.009247  0.000000
  0.299111  0.103053  0.016183  0.000000
  0.373889  0.103053  0.023118  0.000000
  0.448667  0.103053  0.030054  0.000000
  0.523444  0.103053  0.036989  0.018763
  0.598222  0.103053  0.043925  0.038404
  0.673000  0.103053  0.050860  0.050968
  0.747778  0.103053  0.057796  0.060997
  0.822556  0.103053  0.064731  0.069595
  0.897333  0.103053  0.071667  0.077242
  0.972111  0.103053  0.078602  0.084197
  1.046889  0.103053  0.085538  0.090620
  1.121667  0.103053  0.092473  0.096617
  1.196444  0.103053  0.099409  0.102263
  1.271222  0.103053  0.106344  0.107613
  1.346000  0.103053  0.113280  0.112710
  1.420778  0.103053  0.120215  0.117586
  1.495556  0.103053  0.127151  0.122267
  1.570333  0.103053  0.134086  0.126776
  1.645111  0.103053  0.141022  0.131130
  1.719889  0.103053  0.147957  0.135343
  1.794667  0.103053  0.154892  0.139430
  1.869444  0.103053  0.161828  0.143400
```

```
  1.944222  0.103053  0.168763  0.147263
  2.019000  0.103053  0.175699  0.151027
  2.093778  0.103053  0.182634  0.154700
  2.168556  0.103053  0.189570  0.158288
  2.243333  0.103053  0.196505  0.161796
  2.318111  0.103053  0.203441  0.165229
  2.392889  0.103053  0.210376  0.168593
  2.467667  0.103053  0.217312  0.171891
  2.542444  0.103053  0.224247  0.175126
  2.617222  0.103053  0.231183  0.178303
  2.692000  0.103053  0.238118  0.181425
  2.766778  0.103053  0.245054  0.184493
  2.841556  0.103053  0.251989  0.187512
  2.916333  0.103053  0.258925  0.190482
  2.991111  0.103053  0.265860  0.193407
  3.065889  0.103053  0.272796  0.196289
  3.140667  0.103053  0.279731  0.199128
  3.215444  0.103053  0.286667  0.201928
  3.290222  0.103053  0.293602  0.204690
  3.365000  0.103053  0.300538  0.207414
  3.439778  0.103053  0.307473  0.210104
  3.514556  0.103053  0.314409  0.212759
  3.589333  0.103053  0.321344  0.215382
  3.664111  0.103053  0.328280  0.217973
  3.738889  0.103053  0.335215  0.220534
  3.813667  0.103053  0.342151  0.223065
  3.888444  0.103053  0.349086  0.225568
  3.963222  0.103053  0.356022  0.228043
  4.038000  0.103053  0.362957  0.230492
  4.112778  0.103053  0.369893  0.232915
  4.187556  0.103053  0.376828  0.235313
  4.262333  0.103053  0.383763  0.237687
  4.337111  0.103053  0.390699  0.240037
  4.411889  0.103053  0.397634  0.242365
  4.486667  0.103053  0.404570  0.244670
  4.561444  0.103053  0.411505  0.246954
  4.636222  0.103053  0.418441  0.249217
  4.711000  0.103053  0.425376  0.251460
  4.785778  0.103053  0.432312  0.253683
  4.860556  0.103053  0.439247  0.255887
  4.935333  0.103053  0.446183  0.258071
  5.010111  0.103053  0.453118  0.260238
  5.084889  0.103053  0.460054  0.262386
  5.159667  0.103053  0.466989  0.264517
  5.234444  0.103053  0.473925  0.266631
  5.309222  0.103053  0.480860  0.268729
  5.384000  0.103053  0.487796  0.270810
  5.458778  0.103053  0.494731  0.272875
  5.533556  0.103053  0.501667  0.274925
  5.608333  0.103053  0.508602  0.276959
  5.683111  0.103053  0.515538  0.278979
  5.757889  0.103053  0.522473  0.406260
  5.832667  0.103053  0.529409  0.568101
  5.907444  0.103053  0.536344  0.668227
  5.982222  0.103053  0.543280  0.747895
  6.057000  0.103053  0.550215  0.816222
  6.131778  0.103053  0.557151  0.877069
  6.206556  0.103053  0.564086  0.932501
  6.281333  0.103053  0.571022  1.168784
  6.356111  0.103053  0.577957  1.741787
  6.430889  0.103053  0.584893  2.490552
  6.505667  0.103053  0.591828  3.344897
  6.580444  0.103053  0.594910  4.238572
  6.655222  0.103053  0.597993  5.103719
  6.730000  0.103053  0.601075  5.876899
  6.804778  0.103053  0.608781  6.509960
  END FTABLE  1
END FTABLES

EXT SOURCES
```

```
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1.167          PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1.167          IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    0.76           PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.76           IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
COPY     1 OUTPUT MEAN   1 1     48.4      WDM    701 FLOW     ENGL      REPL
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    801 FLOW     ENGL      REPL
COPY   601 OUTPUT MEAN   1 1     48.4      WDM    901 FLOW     ENGL      REPL
RCHRES   1 HYDR   RO     1 1        1      WDM   1022 FLOW     ENGL      REPL
RCHRES   1 HYDR   STAGE  1 1        1      WDM   1023 STAG     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK        2
PERLND     PWATER SURO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    2

  MASS-LINK        3
PERLND     PWATER IFWO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    3

  MASS-LINK        5
IMPLND     IWATER SURO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    5

  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   13

  MASS-LINK       15
IMPLND     IWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   15

  MASS-LINK       16
RCHRES     ROFLOW                          COPY           INPUT  MEAN
  END MASS-LINK   16


END MASS-LINK

END RUN
```

Predeveloped HSPF Message File

Mitigated HSPF Message File

Disclaimer

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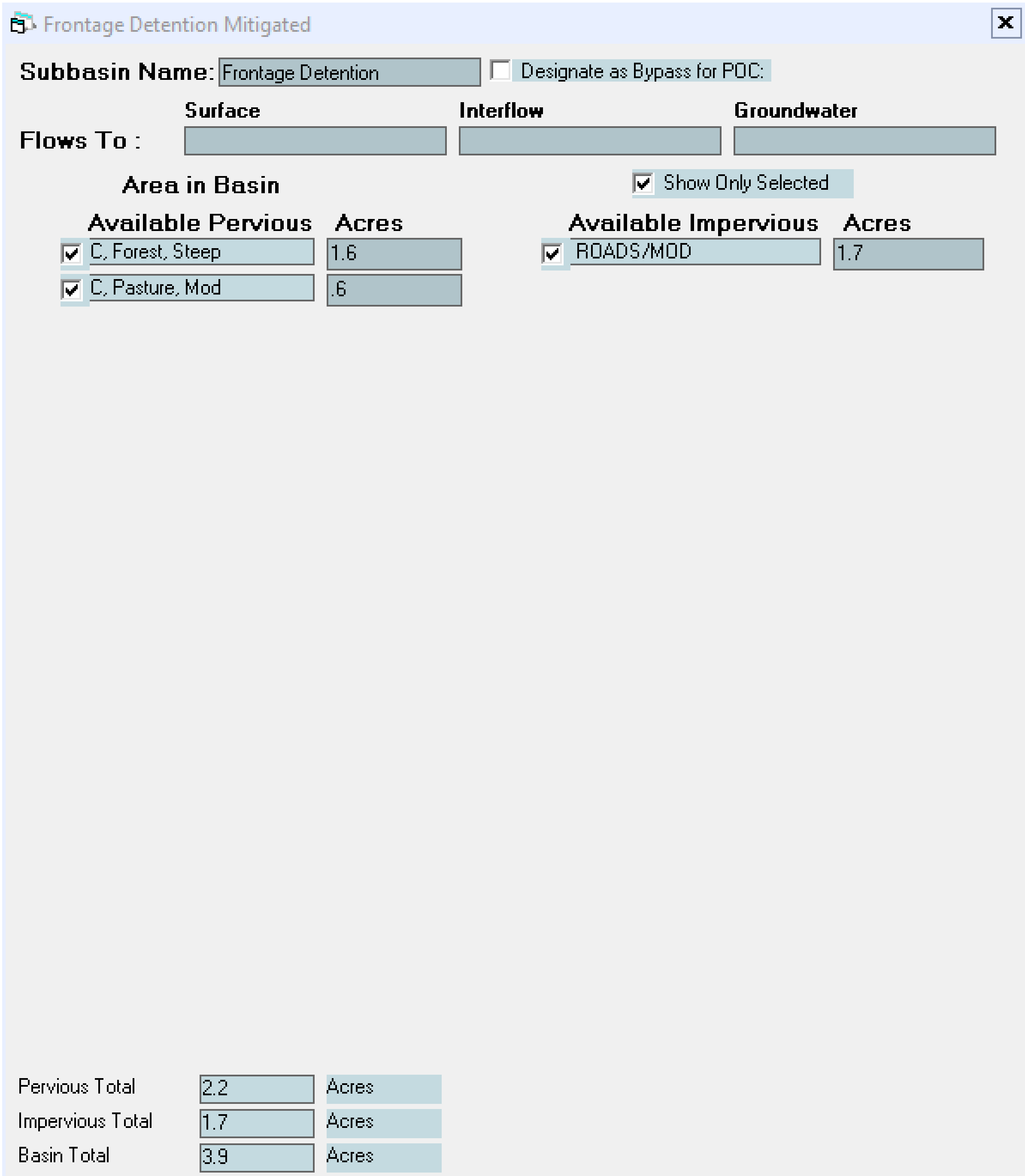
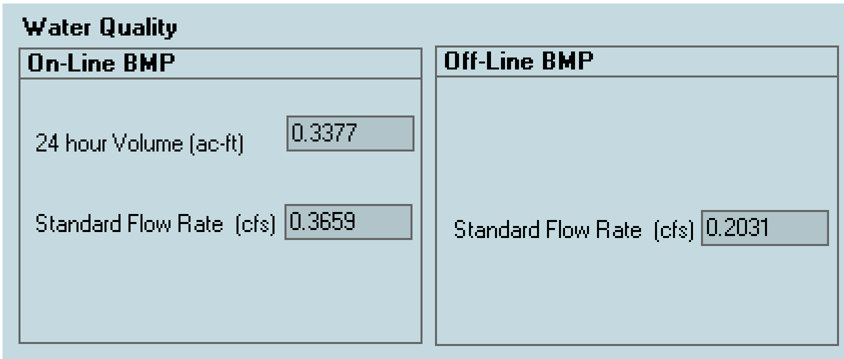
Frontage Treatment Basin



Water quality flow rate from WWHM (upstream of detention)



A 54" flow splitter, SDCB 009 is proposed upstream of the proposed BioPod treatment structure due to the high 100-year overflow rates tributary to this structure. This flow splitter has been designed to discharge the off-line water quality flow rate to the proposed oil/water separator BioPod treatment structure while bypassing higher flows around these treatment structures and discharge directly to detention.

Per Figure 5.1.4.H – Riser Inflow Curves of the *KCSWDM*:

$$Q_{weir} = 9.739\ DH^{3/2}$$
$$Q_{orifice} = 3.782\ D^2H^{1/2}$$
$$Q \text{ in cfs, } D \text{ and } H \text{ in feet}$$

$$Q_{wq} = 0.2031\ cfs$$

$$0.2031\ cfs = 3.782 \times \left(\frac{D}{12} ft\right)^2 \times (1ft)^{1/2}$$

$$D = 2.8"$$

<u>A 2.8" orifice plate is proposed on the WQ outlet pipe with 1' of head within the flow splitter, option A per Figure 4.5.1 of the *SWMMWW*. Access is required on either side of the baffle wall because 4' of clear space cannot be provided between the top of the baffle wall and the bottom of the top slab.</u>

The coalescing plate oil/water separator must be sized based on the off-line standard water quality flow rate. Per 6.2.1 of the *KCSWDM*, the WWHM Off-Line 15-min WQ flow (shown above) must be adjusted by a ratio, *k*, based on the 6-month, 24-hr precipitation (72% of the 2-year) in inches. Per Figure 3.2.1.A of the *KCSWDM*, the project site has a 2-year, 24-hour precipitation of 2.5".

$$2.5" \times 0.72 = 1.8"$$

Per Table 6.2.1.A of the *KCSWDM*, a 6-month, 24-hour precipitation of 1.8" must be linearly interpolated between the k values of 1.50" (3.68) and 2.00" (4.92) to a k value of 4.424.

$$Q_{wq} = 0.2031\, cfs \times 4.424 = 0.8985\, cfs$$

$$A_h = \frac{60 \times Q_{wq}}{0.00386 \times \left(\frac{S_w - S_o}{\mu}\right)} = \frac{60 \times 0.8985\, cfs}{0.00386 \times \left(\frac{1.0 - 0.85}{0.015674}\right)} = 1459.41\, sf$$

<u>An OldCastle 612-2-CPS is proposed as the coalescing plate oil/water separator with a projected coalescing plate area of 1,776 sf.</u>

$$1{,}776\, sf > 1{,}459.41\, sf$$

OldCastle Underground BioPod Biofilters shall be used for water quality treatment. BioPods have DOE GULD approval for Basic, Enhanced, and Phosphorus treatment, refer to Figure 4-4, with a treatment rate of 1.6 gpm per square foot of media surface and a minimum media thickness of 18". The unadjusted WWHM off-line water quality flow rate has been used to size the proposed BioPod structure; the BioPod DOE GULD for enhanced and phosphorus treatment is based on using this WWHM design flow.

$$0.2031\, cfs = 91.1579\, gpm$$

$$91.1579\, gpm \Big/ 1.6\, {gpm}\!\left/ {sf}\right. = 57\, sf$$

<u>A BPU-416 provides 64 sf of media surface (4'x16') which is larger than 57 sf.</u>

Per Figure 4-3, ACF Environmental R-Tank Maintenance Row Sizing is based on the water quality flow rate discharging to the proposed R-Tank detention system. The R-Tank detention systems are not proposed to provide any water quality treatment; the maintenance row is proposed per manufacturer's recommendation. The detention system is not part of the off-line portion of the stormwater system therefore the on-line water quality flow is being used.

$$\#\ of\ Treatment\ Modules = \frac{Design\ Flow\ Rate\ (cfs)}{Unit\ Flow\ Per\ Modules\ (cfs)} = \frac{Water\ Quality\ Flow\ Rate\ (cfs)}{0.191\ cfs}$$

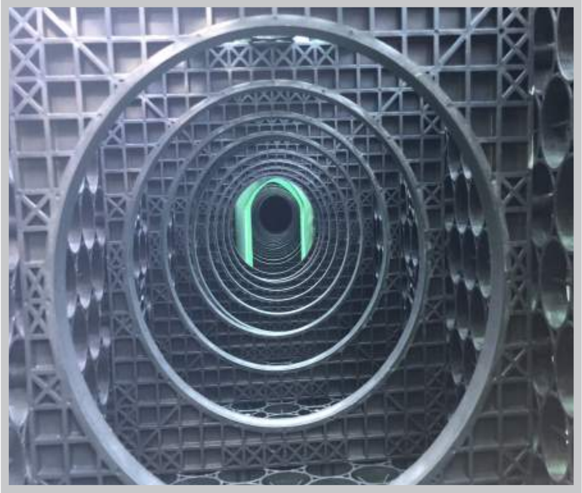
$$\#\ of\ Treatment\ Modules = \frac{0.3659\ cfs}{0.191\ cfs} = 1.92\ Treatment\ Modules$$

<u>2 R-Tank treatment modules are proposed at the inlet of Detention 8.</u>

STORMWATER MANAGEMENT

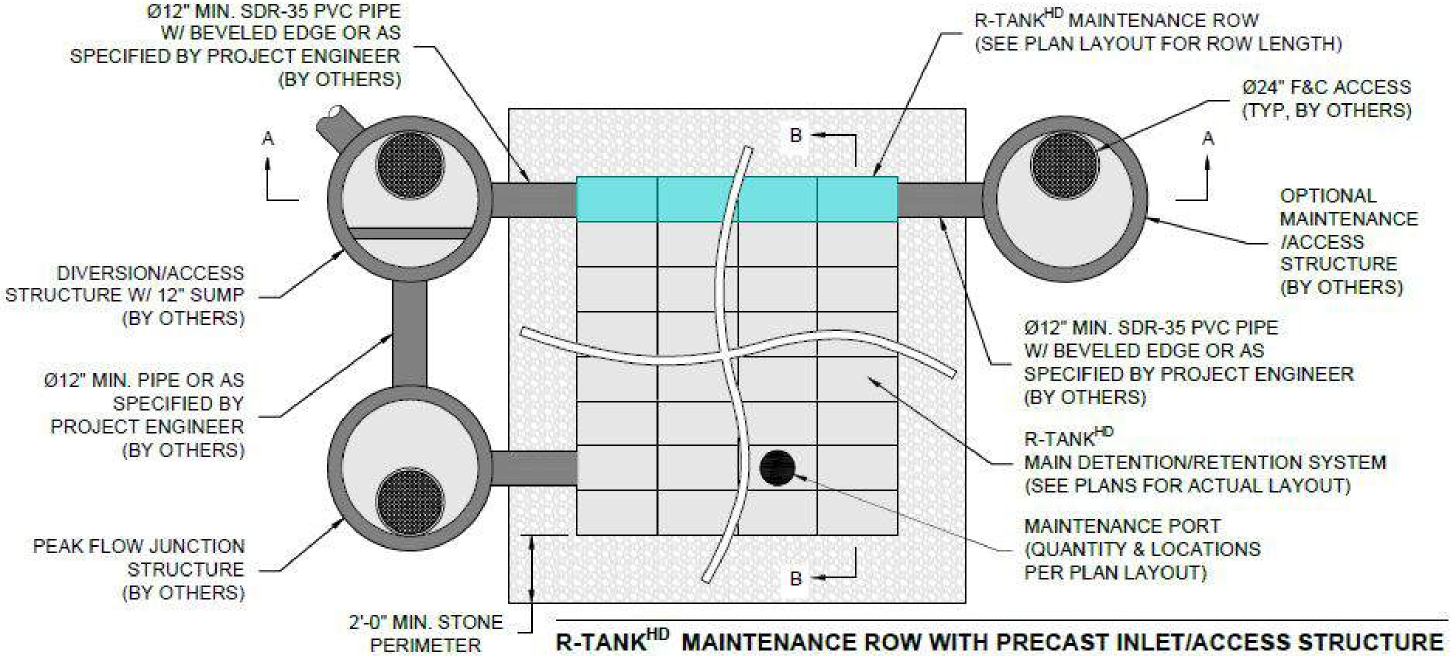
R-TANK®
TREATMENT ROW SIZING

The R-Tank Treatment Row is designed to capture the water quality flow or "first flush" as defined by a regulatory or permitting agency. The system consists of a series of modules utilizing open plates for maintenance access encapsulated by filter fabric and connected to a nearby manhole. The fabric-wrapped modules provide filtration and promote settling of pollutants.



Using ASTM C1746/C1746M-12 TRI Environmental completed full-scale testing in their South Carolina lab to determine the relationship between total suspended solids (TSS) removal and hydraulic load rate. This testing determined that the hydraulic loading rate needed to achieve 80% TSS removal is equal to 0.062 cfs/ft2 or 0.191 cfs per module. Based on this information the sizing of the treatment row is as follows:

$$\textbf{\# of Treatment Modules} = \frac{\textbf{Design Flow Rate (cfs)}}{\textbf{Unit Flow Per Modules (cfs)}}$$



R-TANK^{HD} MAINTENANCE ROW WITH PRECAST INLET/ACCESS STRUCTURE

WASHINGTON STATE DEPARTMENT OF ECOLOGY

October 2019

GENERAL USE LEVEL DESIGNATION FOR BASIC (TSS), DISSOLVED METALS (ENHANCED), AND PHOSPHORUS TREATMENT

For

Oldcastle Infrastructure, Inc.'s
The BioPod™ Biofilter
(Formerly the TreePod Biofilter)

<u>Ecology's Decision:</u>

Based on Oldcastle Infrastructure, Inc. application submissions for the The BioPod™ Biofilter (BioPod), Ecology hereby issues the following use level designation:

1. **General Use Level Designation (GULD) for Basic, Enhanced, and Phosphorus Treatment:**
   - **Sized at a hydraulic loading rate of 1.6 gallons per minute (gpm) per square foot (sq ft) of media surface area.**
   - **Constructed with a minimum media thickness of 18-inches (1.5-feet).**

2. **Ecology approves the BioPod at the hydraulic loading rate listed above, to achieve the maximum water quality design flow rate. The water quality design flow rates are calculated using the following procedures:**
   - **Western Washington: For treatment installed upstream of detention or retention, the water quality design flow rate is the peak 15-minute flow rate as calculated using the latest version of the Western Washington Hydrology Model or other Ecology-approved continuous runoff model.**
   - **Eastern Washington: For treatment installed upstream of detention or retention, the water quality design flow rate is the peak 15-minute flow rate as calculated using one of the three methods described in Chapter 2.2.5 of the Stormwater Management Manual for Eastern Washington (SWMMEW) or local manual.**
   - **Entire State: For treatment installed downstream of detention, the water quality design flow rate is the full 2-year release rate of the detention facility.**

3. **The GULD has no expiration date, but may be amended or revoked by Ecology.**

<u>Ecology's Conditions of Use:</u>

The BioPod shall comply with these conditions:

1) **Applicants shall design, assemble, install, operate, and maintain the BioPod installations in accordance with Oldcastle Infrastructure, Inc.'s applicable manuals and the Ecology Decision.**

2) **The minimum size filter surface-area for use in Washington is determined by using the design water quality flow rate (as determined in Ecology Decision, Item 3, above) and the Infiltration Rate (as identified in Ecology Decision, Item 1, above). Calculate the required area by dividing the water quality design flow rate (cu-ft/sec) by the Infiltration Rate (converted to ft/sec) to obtain required surface area (sq ft) of the BioPod unit**

3) **BioPod media shall conform to the specifications submitted to and approved by Ecology**

4) **Maintenance: The required inspection/maintenance interval for stormwater treatment devices is often dependent on the efficiency of the device and the degree of pollutant loading from a particular drainage basin. Therefore, Ecology does not endorse or recommend a "one size fits all" maintenance cycle for a particular model/size of manufactured filter treatment device.**

   - **The BioPod is designed for a target maintenance interval of 1 year. Maintenance includes replacing the mulch, assessing plant health, removal of trash, and raking the top few inches of engineered media.**
   - **A BioPod system tested at the Lake Union Ship Canal Test Facility in Seattle, WA required maintenance after 1.5 months, or 6.3% of a water year. Monitoring personnel observed similar maintenance issues with other systems evaluated at the Test Facility. The runoff from the Test Facility may be unusual and maintenance requirements of systems installed at the Test Facility may not be indicative of maintenance requirements for all sites.**
   - **Test results provided to Ecology from a BioPod System evaluated in a lab following New Jersey Department of Environmental Protection Laboratory Protocol for Filtration MTDs have indicated the BioPod System is capable of longer maintenance intervals.**
   - **Owners/operators must inspect BioPod systems for a minimum of twelve months from the start of post-construction operation to determine site-specific inspection/maintenance schedules and requirements. Owners/operators must conduct inspections monthly during the wet season, and every other month during the dry season. (According to the SWMMWW, the wet season in western Washington is October 1 to April 30. According to the SWMMEW, the wet season in eastern Washington is October 1 to June 30.) After the first year of operation,**

owners/operators must conduct inspections based on the findings during the first year of inspections.

- **Conduct inspections by qualified personnel, follow manufacturer's guidelines, and use methods capable of determining either a decrease in treated effluent flow rate and/or a decrease in pollutant removal ability.**

5) Install the BioPod in such a manner that you bypass flows exceeding the maximum operating rate and you will not resuspend captured sediment.

6) Discharges from the BioPod shall not cause or contribute to water quality standards violations in receiving waters.

<u>Approved Alternate Configurations</u>
BioPod Internal Bypass

1) The BioPod Internal Bypass configuration may be combined with a Curb Inlet, Grated Inlet, and Piped-In Inlet. Water quality flows and peak flows are directed from the curb, overhead grate, or piped inlet to a contoured inlet rack. The inlet rack disperses water quality flows over the top surface of the biofiltration chamber. Excess flows are diverted over an curved bypass weir to the outlet area without passing through the treatment area. Both water quality flows and bypass flows are combined in the outlet area prior to being discharged out of the system.

2) To select a BioPod Internal Bypass unit, the designer must determine the size of the standard unit using the sizing guidance described above. Systems that have an internal bypass, may use the off-line water quality design flow rate.

3) The internal bypass configuration has a maximum flow rate of 900 gallons per minute. Sites where the anticipated flow rate at the treatment device is larger than 900 gpm must use an external bypass, or size the treatment device for the on-line water quality design flow rate.

Applicant: Oldcastle Infrastructure, Inc.

Applicant's Address: 7100 Longe St, Suite 100
Stockton, CA 95206

Application Documents:

Technical Evaluation Report TreePod™ BioFilter System Performance Certification Project, Prepared for Oldcastle, Inc., Prepared by Herrera Environmental Consultants, Inc. February 2018

Technical Memorandum: Response to Board of External Reviewers' Comments on the Technical Evaluation Report for the TreePod™ Biofilter System Performance Certification Project, Oldcastle, Inc. and Herrera Environmental Consultants, Inc., February 2018

Technical Memorandum: Response to Board of External Reviewers' Comments on the Technical Evaluation Report for the TreePod™ Biofilter System Performance Certification Project, Oldcastle, Inc. and Herrera Environmental Consultants, Inc., January 2018

Application for Pilot Use Level Designation, TreePod™ Biofilter – Stormwater Treatment System, Oldcastle Stormwater Solutions, May 2016

Emerging Stormwater Treatment Technologies Application for Certification: The TreePod™ Biofilter, Oldcastle Stormwater Solutions, April 2016

Applicant's Use Level Request:

- General Use Level Designation as a Basic, Enhanced, and Phosphorus Treatment device in accordance with Ecology's *Stormwater Management Manual for Western Washington*

Applicant's Performance Claims:

Based on results from laboratory and field-testing, the applicant claims the BioPod™ Biofilter operating at a hydraulic loading rate of 153 inches per hour is able to remove:

- 80% of Total Suspended Solids (TSS) for influent concentrations greater than 100 mg/L and achieve a 20 mg/L effluent for influent concentrations less than 100 mg/L.
- 60% dissolved zinc for influent concentrations 0.02 to 0.3 mg/L.
- 30% dissolved copper for influent concentrations 0.005 to 0.02 mg/L.
- 50% or greater total phosphorus for influent concentrations 0.1 to 0.5 mg/L.

Ecology's Recommendations:

Ecology finds that:

- Oldcastle Infrastructure, Inc. has shown Ecology, through laboratory and field testing, that the BioPod™ Biofilter is capable of attaining Ecology's Basic, Total Phosphorus, and Enhanced treatment goals.

Findings of Fact:

Field Testing

1. Herrera Environmental Consultants, Inc. conducted monitoring of the BioPod™ Biofilter at the Lake Union Ship Canal Test Facility in Seattle Washington between November 2016 and April 2018. Herrera collected flow-weight composite samples during 14 separate storm events and peak flow grab samples during 3 separate storm events. The system was sized at an infiltration rate of 153 inches per hour or a hydraulic loading rate of 1.6 gpm/ft^2.
2. The D_{50} of the influent PSD ranged from 3 to 292 microns, with an average D_{50} of 28 microns.
3. Influent TSS concentrations ranged from 17 mg/L to 666 mg/L, with a mean concentration of 98 mg/L. For all samples (influent concentrations above and below 100 mg/L) the bootstrap

estimate of the lower 95 percent confidence limit (LCL 95) of the mean TSS reduction was 84% and the bootstrap estimate of the upper 95 percent confidence limit (UCL95) of the mean TSS effluent concentration was 8.2 mg/L.

4. Dissolved copper influent concentrations from the 17 events ranged from 9.0 µg/L to 21.1 µg/L. The 21.1 µg/L data point was reduced to 20.0 µg/L, the upper limit to the TAPE allowed influent concentration range, prior to calculating the pollutant removal. A bootstrap estimate of the LCL95 of the mean dissolved copper reduction was 35%.
5. Dissolved zinc influent concentrations from the 17 events ranged from 26.1 µg/L to 43.3 µg/L. A bootstrap estimate of the LCL95 of the mean dissolved zinc reduction was 71%.
6. Total phosphorus influent concentrations from the 17 events ranged from 0.064 mg/L to 1.56 mg/L. All influent data greater than 0.5 mg/L were reduced to 0.5 mg/L, the upper limit to the TAPE allowed influent concentration range, prior to calculating the pollutant removal. A bootstrap estimate of the LCL95 of the mean total phosphorus reduction was 64%.
7. The system experienced rapid sediment loading and needed to be maintained after 1.5 months. Monitoring personnel observed similar sediment loading issues with other systems evaluated at the Test Facility. The runoff from the Test Facility may not be indicative of maintenance requirements for all sites.

Laboratory Testing

1. Good Harbour Laboratories (GHL) conducted laboratory testing at their site in Mississauga, Ontario in October 2017 following the New Jersey Department of Environmental Protection Laboratory Protocol for Filtration MTDs. The testing evaluated a 4-foot by 6-foot standard biofiltration chamber and inlet contour rack with bypass weir. The test sediment used during the testing was custom blended by GHL using various commercially available silica sands, which had an average d_{50} of 69 µm. Based on the lab test results:
   a. GHL evaluated removal efficiency over 15 events at a Maximum Treatment Flow Rate (MTFR) of 37.6 gpm, which corresponds to a MTFR to effective filtration treatment area ratio of 1.80 gpm/ft^2. The system, operating at 100% of the MTFR with an average influent concentration of 201.3 mg/L, had an average removal efficiency of 99 percent.
   b. GHL evaluated sediment mass loading capacity over an additional 16 events using an influent SSC concentration of 400 mg/L. The first 11 runs were evaluated at 100% of the MTFR. The BioPod began to bypass, so the remaining 5 runs were evaluated at 90% of the MTFR. The total mass of the sediment captured was 245.0 lbs and the cumulative mass removal efficiency was 96.3%.
2. Herrera Environmental Consultants Inc. conducted laboratory testing in September 2014 at the Seattle University Engineering Laboratory. The testing evaluated the flushing characteristics, hydraulic conductivity, and pollutant removal ability of twelve different media blends. Based on this testing, Oldcastle Infrastructure, Inc. selected one media blend, Mix 8, for inclusion in their TAPE evaluation of the BioPod™ Biofilter.
   a. Herrera evaluated Mix 8 in an 8-inch diameter by 36-inch tall polyvinyl chloride (PVC) column. The column contained 18-inches of Mix 8 on top of 6-inches of pea gravel. The BioPod will normally include a 3-inch mulch layer on top of the media layer; however, this was not included in the laboratory testing.
   b. Mix 8 has a hydraulic conductivity of 218 inches per hour; however, evaluation of the pollutant removal ability of the media was based on an infiltration rate of 115 inches per

hour. The media was tested at 75%, 100%, and 125% of the infiltration rate. Based on the lab test results:

- The system was evaluated using natural stormwater. The dissolved copper and dissolved zinc concentrations in the natural stormwater were lower than the TAPE influent standards; therefore, the stormwater was spiked with 66.4 mL of 100 mg/L Cu solution and 113.6 mL of 1,000 mg/L Zn solution.
- The BioPod removed an average of 81% of TSS, with a mean influent concentration of 48.4 mg/L and a mean effluent concentration of 9.8 mg/L.
- The BioPod removed an average of 94% of dissolved copper, with a mean influent concentration of 10.6 µg/L and a mean effluent concentration of 0.6 µg/L.
- The BioPod removed an average of 97% of dissolved zinc, with a mean influent concentration of 117 µg/L and a mean effluent concentration of 4 µg/L.
- The BioPod removed an average of 97% of total phosphorus, with a mean influent concentration of 2.52 mg/L and a mean effluent concentration of 0.066 mg/L. When total phosphorus influent concentrations were capped at the TAPE upper limit of 0.5 mg/L, calculations showed an average removal of 87%.

Other BioPod Related Issues to be Addressed By the Company:

1. Conduct hydraulic testing to obtain information about maintenance requirements on a site with runoff that is more typical of the Pacific Northwest.

Technology Description: Download at https://oldcastleprecast.com/stormwater/bioretention-biofiltration-applications/bioretention-biofiltration-solutions/

Contact Information:

Applicant:
Chris Demarest
Oldcastle Infrastructure, Inc.
(925) 667-7100
Chris.demarest@oldcastle.com

Applicant website: https://oldcastleprecast.com/stormwater/

Ecology web link: https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Stormwater-permittee-guidance-resources/Emerging-stormwater-treatment-technologies

Ecology: Douglas C. Howie, P.E.
Department of Ecology
Water Quality Program
(360) 407-6444
douglas.howie@ecy.wa.gov

Revision History

Date	Revision
March 2018	GULD granted for Basic Treatment
March 2018	Provisional GULD granted for Enhanced and Phosphorus Treatment
June 2016	PULD Granted
April 2018	GULD for Basic and Provisional GULD for Enhanced and Phosphorus granted, changed name to BioPod from TreePod
July 2018	GULD for Enhanced and Phosphorus granted
September 2018	Changed Address for Oldcastle
December 2018	Added minimum media thickness requirement
May 2019	Changed language on who must Install and maintain the device from Oldcastle to Applicants
August 2019	Added text on sizing using infiltration rate and water quality design flow rate
October 2019	Added text describing ability to use off-line design water quality flow rate for sizing due to internal bypass

Section 5

Conveyance System Analysis and Design

5.0 Conveyance System Analysis and Design

The pipe and structure conveyance and capacity of the proposed improvements was analyzed to make sure adequate conveyance and capacity will be provided by the new stormwater system up to the 100-year storm. The analysis was done using Autodesk Storm and Sanitary Sewer Analysis. Additional overflow analysis was done to show that the proposed piped outfalls for the proposed detention systems have capacity to convey the 100-year inflow to these facilities; this assumes that the proposed systems fail or there are storm events higher than the required design storms. This analysis will be provided in a future engineering submittal with final civil plans.

Section 6

Special Reports and Studies

6.0 Special Reports and Studies

A Subsurface Exploration, Geologic Hazard, and Preliminary Geotechnical Engineering Report has been done by Associated Earth Sciences. This report is dated September 17th, 2019. Soils on site are sloping from 0 to 50 percent. The area topography is made up of a flat region near the center of the project area and slopes falling away at roughly 15 to 30 percent. Soils observed include Vashon Lodgement Till, Vashon Ice Contact Sediments, Olympia Non-Glacial Sediments, Possession Drift, Pre-Faser Till, Pre-Faser Silt, and Blakely harbor Formation. Per the report these soils have little to no hydraulic conductivity meaning infiltration is not feasible on site. For more information regarding soils the full report in Figure 6-1.

Section 6.0 Figures

associated earth sciences incorporated

Subsurface Exploration, Geologic Hazard, and Preliminary Geotechnical Engineering Report

ISSAQUAH HIGH SCHOOL #4 AND ELEMENTARY SCHOOL #17

Issaquah, Washington

Prepared For:

ISSAQUAH SCHOOL DISTRICT

Project No. 180070E001
September 17, 2019

Associated Earth Sciences, Inc.
911 5th Avenue
Kirkland, WA 98033
P (425) 827 7701

associated
earth sciences
incorporated

September 17, 2019
Project No. 180070E001

Issaquah School District
5150 220th Avenue SE
Issaquah, Washington 98029

Attention: Mr. Tom Mullins

Subject: Subsurface Exploration, Geologic Hazard, and
Preliminary Geotechnical Engineering Report
Issaquah High School #4 and Elementary School #17
4221 228th Avenue SE
Issaquah, Washington

Dear Mr. Mullins:

We are pleased to present our preliminary geotechnical engineering report for the referenced project. This report summarizes the results of our subsurface exploration, geologic hazards, and geotechnical engineering studies, and offers preliminary recommendations for the design and development of the proposed project. Our recommendations are preliminary in that project plans and construction details were in preparation at the time this report was written. We should be allowed to review the recommendations presented in this report and modify them, if needed, once final project plans have been formulated.

We have enjoyed working with you on this study and are confident that the recommendations presented in this report will aid in the successful completion of your project. If you should have any questions or if we can be of additional help to you, please do not hesitate to call.

Sincerely,
ASSOCIATED EARTH SCIENCES, INC.
Kirkland, Washington

Stephen A. Siebert, P.E.
Associate Geotechnical Engineer

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SUBSURFACE EXPLORATION, GEOLOGIC HAZARD, AND PRELIMINARY GEOTECHNICAL ENGINEERING REPORT

ISSAQUAH HIGH SCHOOL #4 AND ELEMENTARY SCHOOL #17

Issaquah, Washington

Prepared for:
Issaquah School District
5150 220th Avenue SE
Issaquah, Washington 98029

Prepared by:
Associated Earth Sciences, Inc.
911 5th Avenue
Kirkland, Washington 98033
425-827-7701

September 17, 2019
Project No. 180070E001

I. PROJECT AND SITE CONDITIONS

1.0 INTRODUCTION

This report presents the results of our subsurface exploration, geologic hazard, and preliminary geotechnical engineering study for the new Issaquah High School #4 and Elementary School #17. Our recommendations are preliminary in that project plans and construction details were in preparation at the time this report was written. Our understanding of the project is based on review of preliminary civil plans prepared by AHBL. The site location is shown on the "Vicinity Map," Figure 1. An aerial photo of the site showing the approximate locations of the explorations completed for this study is included in Figure 2. The exploration locations and the locations of the proposed improvements as depicted on the most recent version of the civil plans, are shown on Figure 3. Copies of the exploration logs are included in Appendix A.

1.1 Purpose and Scope

The purpose of this study was to provide subsurface data to be utilized in the preliminary design and development of the referenced project. Our study included reviewing available geologic literature, advancing 31 exploration pits and 12 exploration borings, and performing geologic studies to assess the type, thickness, distribution, and physical properties of the subsurface sediments and groundwater. Geotechnical engineering studies were completed to formulate preliminary recommendations for site preparation, grading, types of suitable foundations and floors, allowable foundation soil bearing pressure, anticipated foundation and floor settlement, drainage considerations, pavement recommendations, construction of athletic fields, and infiltration feasibility. This report summarizes our fieldwork and offers preliminary recommendations based on our present understanding of the project. We recommend that we be allowed to review the recommendations presented in this report and revise them, if needed, when a project design has been finalized.

1.2 Authorization

Our study was accomplished in general accordance with our scope of work and cost proposal, dated November 2, 2018. This report has been prepared for the exclusive use of the Issaquah School District and their agents for specific application to this project. Within the limitations of scope, schedule, and budget, our services have been performed in accordance with generally accepted geotechnical engineering and engineering geology practices in effect in this area at the time our report was prepared. No other warranty, express or implied, is made.

2.0 PROJECT AND SITE DESCRIPTION

The subject site consists of three parcels totaling approximately 40-acres located at 4441, 4443, and 4461 228th Avenue SE in Issaquah, Washington (King County Parcel Nos. 1624069001, 1624069029, and 1624069031). Access to the site is gained via two paved driveways off 228th Avenue SE. The site is located adjacent to the Providence Point neighborhood, which borders the site to the north, south, and west. The site is bounded to the east by 228th Avenue SE, beyond which lies the Sammamish Highlands neighborhood.

As shown on Figure 2, the site generally consists of an elevated relatively flat to gently sloping plateau located in the central portion of the site. The topography generally slopes down from the central plateau toward the northeast, south, and southwest. Elevations on the site range from a low of approximately 415 feet near the northeastern corner of the site to a maximum of approximately 526 feet in the southern portion of the site. Slope inclinations on the site generally range from approximately 30 percent or less, but steepen to a maximum of approximately 50 percent in a relatively small area located near the southeast corner of the property. This steep slope appears to be a cut slope made for the construction of 228th Avenue SE and the south entrance road into the property.

The property was previously developed with a church, dormitories, and accessory buildings. These structures were in the process of being demolished during our initial phase of field exploration in December of 2018, but the demolition had been completed by the time of our second phase of exploration in June of 2019. Grading associated with the demolition has resulted in some localized areas of steep slopes in the areas of the former structures. Maximum slope inclinations in these areas were visually estimated to be up to approximately 2H:1V (Horizontal:Vertical). A water tank located in the southern portion of the site remains in place.

Based on review of civil plan sheets prepared by AHBL, dated May 20, 2019, we understand that preliminary development plans for the site consist of a new high school and elementary school. The high school building will be located in the southern portion of the site and the elementary school building in the western portion of the site. The high school will have a football field and track, baseball and softball fields, tennis courts above a parking structure, surface parking, and space for future portable classrooms. The elementary school will have play areas, surface parking, and space for future portable classrooms. The proposed facility layout is shown in Figure 3.

Maximum cuts for the project will be up to approximately 17 to 18 feet and will be located in the southern portion of the site in the area of the proposed high school building. A maximum fill depth of approximately 41 feet will be located in the northeastern portion of the site in the area of the proposed baseball field. We understand that conceptual plans include the use of mechanically stabilized earth (MSE) walls to facilitate proposed grade changes in some areas. The conceptual grading plan shows maximum retaining wall heights of approximately 19 feet along the southwest site margin and in the northeastern portion of the site in the area of the baseball field.

The civil plans show six stormwater detention facilities planned across the site. The detention facilities consist of prefabricated Stormtank^{TM} modules, or a similar underground detention system, that will be located below the elementary school building play area, below the high school football and baseball fields, below a traffic loop south of the high school building, and in an area in the northeastern portion of the site.

3.0 SUBSURFACE EXPLORATION

Our field study included advancing 31 exploration pits and 12 exploration borings at the site. This information was supplemented by 20 additional exploration pits completed at the site for previous geotechnical studies by Terra Associates, Inc. (Terra) in July 2015 and by Earth Solutions NW (ESNW) in May 2014. These exploration logs were included in a report titled "Geotechnical Report, Madison Pointe," prepared by Terra for Murray Franklyn Companies, Project No. T7252, dated March 18, 2016. A copy of this report was provided to us by the District. It should be noted that the log of ESNW exploration pit TP-2 was not included in the report. The approximate locations of the explorations are shown on Figures 2 and 3. The conclusions and recommendations presented in this report are based on the explorations completed for this study. The number, locations, and depths of our explorations were completed within site and budgetary constraints. Copies of the exploration logs are included in Appendix A.

Because of the nature of exploratory work below ground, extrapolation of subsurface conditions between field explorations is necessary. It should be noted that subsurface conditions between the explorations may differ from those inferred by the boring data due to the random nature of deposition and the alteration of topography by past grading and/or filling. The nature and extent of any variations between the field explorations may not become fully evident until construction. If variations are observed at that time, it may be necessary to re-evaluate specific recommendations in this report and make appropriate changes.

3.1 Exploration Pits

The exploration pits were excavated using a track-mounted excavator. The pits permitted direct, visual observation of subsurface conditions. Materials encountered in the exploration pits were studied and classified in the field by an engineering geologist from our firm. All of the exploration pits were backfilled immediately after examination and logging. Samples collected from the exploration pits were classified in the field and representative portions placed in watertight containers. The samples were then transported to our laboratory for further visual classification and laboratory testing.

3.2 Exploration Borings

The exploration borings drilled for our study were completed using a track-mounted, hollow-stem auger drill rig. During the drilling process, samples were generally obtained at 2.5- to 5-foot-depth intervals. The exploration borings were continuously observed and logged by an engineering geologist from our firm. The exploration logs presented in Appendix A are based on the field logs, drilling action, and review of the samples collected.

Disturbed, but representative samples were obtained by using the Standard Penetration Test (SPT) procedure in accordance with *American Society for Testing and Materials* (ASTM) D-1586. This test and sampling method consists of driving a standard 2-inch, outside-diameter, split-barrel sampler a distance of 18 inches into the soil with a 140-pound hammer free-falling a distance of 30 inches. The number of blows for each 6-inch interval is recorded, and the number of blows required to drive the sampler the final 12 inches is known as the Standard Penetration Resistance ("N") or blow count. If a total of 50 is recorded within one 6-inch interval, the blow count is recorded as the number of blows for the corresponding number of inches of penetration. The resistance, or N-value, provides a measure of the relative density of granular soils or the relative consistency of cohesive soils; these values are plotted on the boring logs in Appendix A.

The samples obtained from the split-barrel sampler were classified in the field and representative portions placed in watertight containers. The samples were then transported to our laboratory for further visual classification.

4.0 SUBSURFACE CONDITIONS

Subsurface conditions at the project site were inferred from the field explorations accomplished for this study, visual reconnaissance of the site, and review of selected geologic literature. Detailed descriptions of the sediments encountered in each of the borings are provided on the exploration logs in Appendix A. The explorations generally encountered natural sediments consisting of granular, glacial sediments underlain by weathered sedimentary rock. Fine-grained glacial sediments and/or glacially consolidated non-glacial sediments were also encountered in some locations. In some areas of the site, the natural deposits were overlain by fill soils. The following section presents more detailed subsurface information organized from the shallowest (youngest) to the deepest (oldest) sediment types.

4.1 Stratigraphy

Fill

Fill soils (those not naturally deposited) were encountered in 11 of the explorations at the site. Where encountered, the existing fill generally consisted of loose to dense, gravelly, silty to very silty sand. Portions of the fill contained trace to abundant quantities of wood debris. In general, the areas where existing fill soils were encountered were located near the former buildings, pavement areas, and property margins. Where encountered in our explorations, the existing fill soils ranged in thickness from approximately 1 to 9 feet.

Excavated existing fill material is suitable for reuse in structural fill applications if such reuse is specifically allowed by project plans and specifications, if excessively organic and any other deleterious materials are removed, and the moisture content is suitable for compaction to the specified level. Because of its variable, and sometimes low relative density, the existing fill soil is not suitable for support of building foundations or other structures. The thicknesses of the existing fill soils encountered in the explorations are summarized in Table 1.

Table 1
Summary of Observed Fill Thicknesses

Exploration	Fill Thickness (feet)
EP-7	1
EP-8	8
EP-9	1
EP-11	6
EP-16	4
EP-18	2
EB-4	2.5
EB-8	4.5
EB-9	2.5
TP-6 (Terra, 2015)	1
TP-5 (ESNW, 2014)	9

Forest Duff/Topsoil

A surficial forest duff/topsoil horizon was encountered in most of our explorations located outside of areas of existing fill or asphalt pavement. Where encountered in our explorations, the thickness of the forest duff/topsoil horizon generally ranged from approximately 2 to 8 inches. Organic topsoil thicknesses shown on the Terra and ESNW exploration logs generally ranged from approximately 6 inches to 2 feet. Due to its high organic content, the forest duff/topsoil horizon is not suitable for foundation support or for use as structural fill.

Vashon Lodgement Till

With the exception of exploration pit EP-4, the natural sediments encountered in our exploration pits either directly below the ground surface, the surficial topsoil horizon, or the surficial fill layer generally consisted of loose to medium dense, non-stratified, silty to very silty, gravelly sand with scattered cobbles. These sediments typically became dense to very dense below depths ranging from approximately 6 inches to 6 feet. We interpret these sediments to be representative of Vashon lodgement till. The Vashon lodgement till was deposited directly from basal, debris-laden, glacial ice during the Vashon Stade of the Fraser Glaciation, approximately 12,500 to 15,000 years ago. The high relative density characteristic of the Vashon lodgement till is due to its consolidation by the massive weight of the glacial ice from which it was deposited. The reduced density observed in the upper portion of the till is interpreted to be due to weathering.

Lodgement till sediments were also encountered in the upper portions of exploration borings EB-1, EB-2, EB-5 through EB-9, EB-11, and EB-12, and appear to have been encountered in all of the ESNW and Terra exploration pits except Terra pit TP-6. The Terra and ESNW exploration logs do not consistently identify the geologic units encountered. However, in their report, Terra describes these sediments as consisting of lodgement till. At the locations of exploration borings EB-5, EB-8, EB-11, and EB-12, and in Terra pits TP-4, TP-5, and TP-8, the till extended to depths ranging from approximately 2 to 28 feet. Where encountered elsewhere in the explorations, the till extended beyond the maximum depths explored of approximately 4.5 to 15.5 feet. Exploration borings EB-1, EB-2, and EB-7 met with driller refusal in the till at depths of approximately 10 to 15.5 feet. In addition to cobbles, lodgement till typically contains scattered boulders and the difficult drilling conditions encountered at these locations are likely due to the presence of boulders and/or clusters of cobbles in the till.

Lodgement till typically possesses high-strength and low-compressibility attributes that are favorable for support of foundations, floor slabs, and paving with proper preparation. Lodgement till is silty and moisture-sensitive. In the presence of moisture contents above the optimum moisture content for compaction purposes, lodgement till can be easily disturbed by vehicles, earthwork equipment, and even foot traffic. Careful management of moisture-sensitive soils, as recommended in this report, will be needed to reduce the potential for disturbance of wet lodgement till soils and costs associated with repairing disturbed soils. Excavated lodgement till sediments are suitable for reuse in structural fill applications if specifically allowed by project specifications, and if moisture conditions are adjusted to allow compaction to a firm and unyielding condition at the time of construction. If the moisture content of these sediments is elevated at the time of construction, moisture conditioning of the till could be achieved by spreading out the soil proposed for use as structural fill and aerating it during favorable dry site and weather conditions.

Vashon Ice Contact Sediments

Sediments encountered below the weathered till horizon in boring EB-12, approximately 2 feet below the ground surface, generally consisted of stiff to very stiff, fine sandy silt with trace to some gravel. We interpret these sediments to be representative of material deposited by meltwater in close proximity to the glacial ice during Vashon time. At the location of boring EB-12, the ice contact sediments extended to a depth of approximately 14.5 feet. With proper preparation, the ice contact deposits are suitable for support of foundations, floor slabs, and paving. Because of the fine-grained, non-granular texture, these sediments are highly moisture-sensitive and subject to disturbance when wet. Suitable compaction of fine-grained deposits is only achievable over a narrow range of moisture contents. Moisture conditioning of these sediments is difficult due to their cohesive, non-granular texture. For these reasons, we do not recommend the use of these sediments as structural fill. Because the ice contact sediments were only encountered in boring EB-12, their distribution at the site appears to be very limited.

Olympia Non-Glacial Sediments

Sediments encountered at a depth of approximately 28 feet (below the Vashon lodgement till) in boring EB-11, generally consisted of very dense, tan-gray, fine to medium sand with moderate to high silt content. Below a depth of approximately 33.5 feet, the sediments of this geologic unit consisted of hard, tan silt with trace gravel. The silt was generally massive but contained scattered, thin, sandy lenses. Although we observed no clear, distinguishing features characteristic of a particular geologic unit, their color, gradation, and stratigraphic position below the lodgement till suggest that these sediments may be representative of material deposited during the Olympia non-glacial period. The Olympia non-glacial period occurred prior to the Fraser Glaciation, approximately 30,000 to 60,000 years ago. At the location of exploration boring EB-11, these sediments extended to a depth of approximately 48 feet. Because these sediments lie below the maximum anticipated excavation depth for the project, use of these sediments for foundation support or as structural fill is not expected.

Possession Drift

Sediments encountered below the Vashon lodgement till in boring EB-8 generally consisted of very stiff to hard, blue-gray silt. The silt was generally massive to laminated and contained scattered fine sand partings. These sediments effervesced in hydrochloric acid. We interpret these sediments to be representative of Possession Drift. The Possession Drift was deposited in a glaciomarine environment during the Possession Glaciation, approximately 60,000 to 80,000 years ago. At the location of boring EB-8, the Possession Drift extended beyond the maximum depth explored of approximately 26.5 feet. Because these sediments lie below the maximum anticipated excavation depth in the area of boring EB-8, use of these sediments for foundation support or as structural fill is not expected.

Pre-Fraser Till

Sediments encountered below a depth of approximately 48 feet in boring EB-11 generally consisted of very dense, non-stratified, very silty, gravelly sand. Although these sediments appeared texturally similar to the Vashon lodgement till, their stratigraphic position below the suspected Olympia-aged non-glacial sediments indicate that they were deposited during a glacial period prior to the Fraser Glaciation. At the location of boring EB-11, the pre-Fraser till extended to a depth of approximately 68 feet. Because these sediments lie below the maximum anticipated excavation depth for the project, use of these sediments for foundation support or as structural fill is not expected.

Pre-Fraser Silt

Sediments encountered below the pre-Fraser till in boring EB-11 (below a depth of approximately 68 feet) generally consisted of hard silt with lenses and interbeds of very silty, fine sand. Based on their stratigraphic position below the pre-Fraser silt, deposition of these sediments also occurred prior to the Fraser Glaciation. These sediments were non-reactive in hydrochloric acid. At the location of boring EB-11, the pre-Fraser silt extended to a depth of approximately 80 feet. Because these sediments lie below the maximum anticipated excavation depth for the project, use of these sediments for foundation support or as structural fill is not expected.

Blakely Harbor Formation

Sediments encountered below the surficial topsoil horizon in exploration pit EP-4 consisted of loose, brown, very silty sand with some gravel and soft to medium stiff, yellowish-tan silt. These sediments became medium dense to dense below a depth of approximately 5.5 feet. The gravel-sized fraction of these sediments typically consisted of angular sedimentary rock. Similar sediments were encountered either directly below the surficial topsoil horizon, or below the lodgement till or pre-Fraser sediments in exploration borings EB-3 through EB-6, and EB-10 through EB-12. We interpret these sediments to be representative of the Blakely Harbor Formation. The Blakely Harbor Formation consists of a Miocene-aged sedimentary rock composed of sandstone, siltstone, conglomerate, tuff, and volcaniclastic sandstone. It is known to contain interbeds of coal, and in some locations, nearly coherent logs. Where encountered in our explorations, the bedrock was typically weathered and poorly lithified and exhibited physical characteristics more consistent with a non-lithified sediment than well indurated bedrock. However, the density/lithification of these sediments typically increased with depth. Sedimentary rock is also noted on the exploration logs for Terra pits TP-4 through

TP-6, and TP-8. At these locations the bedrock was encountered at depths ranging from approximately 2.5 to 9 feet.

In our opinion, the bedrock will typically be rippable with conventional excavation equipment to the penetration depths achievable by the hollow-stem auger drilling rig used for our exploration. Exploration borings EB-4 through EB-6, EB-10, and EB-12 met with refusal in the bedrock at depths ranging from approximately 12 to 20 feet. Refusal depths and elevations for these boring locations are summarized below in Table 2. It should be noted that the refusal elevations shown in Table 2 were estimated from the Light Detection and Ranging (LIDAR) based topography shown on Figure 2. The elevations shown in Table 2 should be considered accurate to the degree implied by the methods used to estimate them.

Exploration borings EB-4, EB-5, and EB-6 are located within the footprint of the proposed high school building. Although the estimated drilling refusal elevations all lie below the finished floor elevation of 510 feet, the density/lithification of the rock varies with both depth and location. We recommend that the contractor be prepared to use specialized rock-breaking equipment in the event that excavation in the bedrock cannot be achieved using conventional excavation equipment.

Table 2
Summary of Drilling Refusal Depths in the Blakely Harbor Formation Bedrock

Boring #	Depth to Drilling Refusal (Ft.)	Apx. Drilling Refusal Elevation (Ft.)
EB-4	20	494
EB-5	14	506
EB-6	12	508
EB-10	20	445
EB-12	18	487

With proper preparation, the Tertiary bedrock is suitable for support of foundations, floor slabs, and paving. Because of its elevated silt content, the weathered bedrock is moisture-sensitive and subject to disturbance when wet. The granular portions of the bedrock are suitable for reuse in structural fill applications if specifically allowed by project specifications, and if moisture conditions are adjusted to allow compaction to a firm and unyielding condition at the time of construction. Portions of the weathered bedrock composed predominantly of silt and clay are not recommended for use as structural fill.

4.2 Geologic Map Review

Review of the regional geologic map titled *Geologic Map of the Issaquah 7.5' Quadrangle, King County, Washington*, by Booth and Minard (1992) indicates that the area of the site is underlain by Vashon lodgement till with Tertiary sedimentary rock mapped in portions of the southern and eastern parts of the site. Our interpretation of the sediments encountered in our explorations is consistent with the regional geologic map.

4.3 Hydrology

Slow to moderately rapid groundwater seepage was observed in 11 of the Associated Earth Sciences, Inc. (AESI) exploration pits. Seepage was also noted on three of the ESNW pits. Specifically, groundwater seepage was encountered in AESI exploration pits EP-4, EP-6, EP-10, EP-11, EP-13 through EP-15, EP-18, EP-19, and EP-31, and in ESNW pits TP-1, TP-3, and TP-4. Generally, the seepage was limited to a thin perched zone in the lower portion of the weathered till horizon within 4 feet of the ground surface. Similarly, shallow, perched seepage was encountered on the surface of the bedrock in exploration pit EP-4. This perched seepage, known as "interflow" occurs when stormwater infiltrates through the relatively permeable, weathered soil horizon and becomes perched atop the underlying, dense, low permeability, unweathered till or bedrock. The exceptions were exploration pits EP-6 and EP-11. In exploration pit EP-6, a zone of thin, perched seepage was encountered in the unweathered till at a depth of approximately 7 feet and in exploration pit EP-11 a zone of thin, perched seepage was encountered at a depth of approximately 2 feet in fill. The occurrence or level of seepage below the site likely varies in response to changes in season, precipitation, and other factors.

II. GEOLOGIC HAZARDS AND MITIGATIONS

The following discussion of potential geologic hazards is based on the geologic conditions as observed and discussed herein.

5.0 LANDSLIDE HAZARDS AND RECOMMENDED MITIGATION

Slope inclinations on the site generally range from approximately 30 percent or less, but steepen to approximately 40 to 50 percent over a maximum height of approximately 30 feet in a relatively small area located near the southeast corner of the property. Based on the morphology of the topography in this area, we interpret the steep slope to be a cut slope made for the construction of 228th Avenue SE and the south entrance road into the property.

Section 18.10.390 of the *Issaquah Municipal Code* (IMC) defines Steep Slope Hazard Areas as any ground that rises at an inclination of 40 percent or more within a vertical elevation change of at least 10 feet. Section 18.10.580 of the IMC states that a buffer shall be established at a horizontal distance of 50 feet from the top, toe, and sides of Steep Slope Hazard Areas with an additional 15-foot building setback established from the edge of the buffer. The buffer may be reduced to a minimum of 10 feet upon acceptance by the City of a geotechnical study supporting the buffer reduction. Alteration of steep slopes are generally prohibited under the code with limited alterations allowed for trails, utilities, and surface water conveyance. The City may grant an exemption from the prohibition of steep slope alteration under the following conditions:

1. Where the height of a steep slope is 20 feet or less. In this case, an alteration may be granted upon review and acceptance by the City of a soils report prepared by a geologist or licensed geotechnical engineer demonstrating that no adverse impact will result from the exemption.

2. Where the slope has been created from previous legal grading activities. In this case, any remaining steep slope shall be subject to the protection mechanisms for steep slopes specified in the code.

Steep slope protection mechanisms specified in Section 18.10.580 of the IMC include a factor of safety of at least 1.5.

Review of the May 20, 2019 grading plans prepared by AHBL civil engineers indicates that the project will entail some grading of the steep slopes. A copy of the grading plan prepared for this area is shown in Figure 4. As previously stated, we interpret the steep slopes to consist of cut slopes associated with grading for construction of 228th Avenue SE and the entrance road into the property off of 228th Avenue SE. Consequently, alteration of these slopes is allowed under Section 18.10580D of the IMC, subject to the protection mechanisms specified in the code.

5.1 Slope Reconnaissance

We completed a reconnaissance of the steep slopes at the site at the time of our field exploration. During our reconnaissance of these areas we did not observe any geomorphologic indications of historic landslide activity, such as tension cracks, landslide scarps, or hummocky topography. No emergent seepage or unusually deformed tree trunks indicative of historical or ongoing slope movement were observed.

5.2 LIDAR Mapping

LIDAR based imagery is a remote sensing technology that can be used to generate a detailed expression of ground surface topography even in densely vegetated areas. For this reason, LIDAR based topographic imagery can be helpful in distinguishing surface features (such as old landslide features) that may otherwise not be easily recognizable. A LIDAR based shaded relief map of the subject site is included as Figure 5. We did not observe any indications of historic landslide activity during our review of the LIDAR shaded relief map.

5.3 Slope Stability Analysis

An analysis of the global stability of the slope in the southeast corner of the site was conducted using the computer program SLOPE/W, version 7.23 by GeoSlope International. The program used the Morgenstern-Price method for evaluating a rotational failure. Input parameters for the analysis included slope geometry, geology, and soil strength parameters. The slope geometry used for our analysis was based on the topography depicted on the civil grading plan along section lines A-A’ and B-B’ (Figure 4). These sections extend through the steepest and highest portions of the slope. The following cases were analyzed for each of these two sections:

- Existing topographic conditions, static case.
- Existing topographic conditions, seismic case.
- Post-construction (post-grading) conditions, static case.
- Post-construction conditions, seismic case.

Subsurface exploration in this area indicates that the slope is underlain by bedrock with Vashon lodgement till overlying the bedrock in most areas. Because the shear strength of the bedrock is estimated to be equivalent to or stronger than the lodgement till, we conservatively assumed that the native sediments underlying the slope consist entirely of lodgement till. Soil strength parameters used for our analysis were assumed based on typical published values for lodgement till and our prior experience. The soil strength parameters used for our analysis are shown on the SLOPE/W profiles included in Appendix B. For evaluation of slope stability under seismic conditions, a horizontal ground acceleration of 0.26g was used for our analysis. This value is equivalent to ½ of the peak horizontal ground acceleration based on a seismic event with a 2 percent probability of exceedance in 50 years in accordance with the 2015 *International Building Code* (IBC).

The stability of a slope can be expressed in terms of its factor of safety. The factor of safety of a slope is the ratio between the forces that resist sliding to the forces that drive sliding. For example, a factor of safety of 1.0 would indicate a slope where the driving forces and the resisting forces are exactly equal. Increasing factor of safety values greater than 1.0 indicate increased stability. Factors of safety below 1.0 indicate conditions where the driving forces exceed the resisting forces and landsliding is imminent.

Under static conditions, the minimum calculated factors of safety all exceeded the minimum value of 1.5 specified in the IMC. The IMC does not specify a minimum factor of safety for seismic conditions, but as a typical standard of practice, a factor of safety of 1.1 is generally considered to be a minimum acceptable value. The minimum factors of safety calculated for seismic conditions all exceeded a factor of safety of 1.5. The minimum calculated factors of safety are summarized below in Table 3. Copies of the results of the slope stability analysis are included in Appendix B.

Table 3
Summary of Minimum Calculated Factors of Safety

Section Line	Case	Minimum Factor of Safety
A-A’	Existing Static	2.43
A-A’	Existing Seismic	1.52
A-A’	Post-Construction Static	3.69
A-A’	Post-Construction Seismic	2.13
B-B’	Existing Static	2.64
B-B’	Existing Seismic	1.62
B-B’	Post-Construction Static	2.65
B-B’	Post-Construction Seismic	1.61

5.4 Landslide Hazard Mitigation

Based on our observations and analyses, it is our opinion that the risk of damage to the proposed project by landsliding on the steep slope is low under both static and seismic conditions, with minimum calculated factors of safety exceeding the minimum acceptable value specified in the IMC. This opinion assumes that construction practices for the project will be completed in accordance with the recommendations presented in this report. We recommend that stormwater discharge on or adjacent to the top of the steep slope be avoided as it could increase the potential for accelerated erosion and negatively impact the stability of the slope.

As previously discussed, some areas of steep slope were generated during grading associated with the demolition of the former buildings. Post-demolition topography is not included on the project grading plans and therefore these steep slopes are not shown. However, the current grading plans indicate that grading proposed for the project will eliminate any steep slopes resulting from the demolition activities. At the time this report was prepared, development plans for the project were conceptual. We recommend that AESI review the final plans to verify that they comply with our recommendations.

6.0 SEISMIC HAZARDS AND RECOMMENDED MITIGATION

Earthquakes occur in the Puget Sound Lowland with great regularity. The vast majority of these events are small and are usually not felt by people. However, large earthquakes do occur as evidenced by the most recent 6.8-magnitude event on February 28, 2001, near Olympia Washington, the 1965 6.5-magnitude event, and the 1949 7.2-magnitude event. The 1949 earthquake appears to have been the largest in this area during recorded history. Evaluation of return rates indicates that an earthquake of the magnitude between 5.5 and 6.0 is likely within a given 20-year period.

Generally, there are four types of potential geologic hazards associated with large seismic events: 1) surficial ground rupture, 2) seismically induced landslides, 3) liquefaction, and 4) ground motion. The potential for each of these hazards to adversely impact the proposed project is discussed below.

6.1 Surficial Ground Rupture

The subject site is located near both the South Whidbey Island Fault Zone (SWIFZ), and the Seattle Fault Zone.

A 2005 study by the U.S. Geological Survey (USGS) (Sherrod et al., 2005, *Holocene Fault Scarps and Shallow Magnetic Anomalies Along the Southern Whidbey Island Fault Zone Near Woodinville, Washington*, Open-File Report 2005-1136, March 2005) reported that "strong" evidence of prehistoric earthquake activity has been observed along two fault strands thought to be part of the southeastward extension of the SWIFZ. The study suggests as many as nine earthquake events along the SWIFZ may have occurred within the last 16,400 years. The recognition of this fault splay is relatively new, and data pertaining to it are limited with the studies still ongoing. The recurrence interval of movement along this fault system is still unknown, although it is hypothesized to be in excess of 1,000 years.

Studies of the Seattle Fault Zone by the USGS (e.g., Johnson et al., 1994, *Origin and Evolution of the Seattle Fault and Seattle Basin, Washington*, Geology, v. 22, pp. 71-74; and Johnson et al., 1999, *Active Tectonics of the Seattle Fault and Central Puget Sound Washington - Implications for Earthquake Hazards*, Geological Society of America Bulletin, July 1999, v. 111, n. 7, pp. 1042-1053) have provided evidence of surficial ground rupture along a northern splay of the Seattle Fault. According to the USGS studies, the latest movement of this fault was about 1,100 years ago when about 20 feet of surficial displacement took place. This displacement can presently be seen in the form of raised, wave-cut beach terraces along Alki Point in West Seattle and Restoration Point at the south end of Bainbridge Island. The recurrence interval of movement along this fault system is still unknown, although it is hypothesized to be in excess of several thousand years.

Due to the suspected long recurrence intervals for both fault zones, the potential for surficial ground rupture is considered to be low during the expected life of the proposed structure.

6.2 Seismically Induced Landslides

It is our opinion that the potential risk of damage to the proposed structures by seismically induced landsliding is low. Landslide hazards were previously discussed in greater detail in the "Landslide Hazards and Recommended Mitigation" section of this report.

6.3 Liquefaction

Liquefaction is a process through which unconsolidated soil loses strength as a result of vibrations, such as those which occur during a seismic event. During normal conditions, the weight of the soil is supported by both grain-to-grain contacts and by the fluid pressure within the pore spaces of the soil below the water table. Extreme vibratory shaking can disrupt the grain-to-grain contact, increase the pore pressure, and result in a temporary decrease in soil shear strength. The soil is said to be liquefied when nearly all of the weight of the soil is supported by pore pressure alone. Liquefaction can result in deformation of the sediment and settlement of overlying structures. Areas most susceptible to liquefaction include those areas underlain by non-cohesive silt and sand with low relative densities, accompanied by a shallow water table.

In our opinion, the potential risk of damage to the proposed structures by liquefaction is low due to the high relative density of the underlying sediments and bedrock, and the lack of adverse groundwater conditions. The site does not classify as a Seismic Hazard Area under the IMC.

6.4 Ground Motion/Seismic Site Class (2015 *International Building Code*)

Structural design of the building should follow 2015 IBC standards. We recommend that the project be designed in accordance with Site Class "C" as defined in IBC Table 20.3-1 of *American Society of Civil Engineers* (ASCE) *7 – Minimum Design Loads for Buildings and Other Structures*.

7.0 EROSION HAZARDS AND MITIGATION

The site soils contain significant quantities of silt and fine sand and are considered to be sensitive to erosion and disturbance when wet. Review of the Natural Resource Conservation Service (NRCS) Web Soil Survey indicates that soil in the area of the subject site is mapped as "*Alderwood gravelly sandy loam, 8 to 15 percent slopes (AgC)*, *Alderwood gravelly sandy loam, 15 to 30 percent slopes (AgD)*," and "*Beausite gravelly sandy loam, 15 to 30 percent slopes.*" The Alderwood soils are derived from lodgement till and the Beausite soils are derived from till and sandstone. The mapped soil types are generally consistent with the soil conditions observed in our explorations. Portions of the site which exhibit slope inclinations in excess of 15 percent classify as Erosion Hazard Areas under the IMC. Section 18.10.520 of the IMC restricts clearing activities in Erosion Hazard Areas to between April 1st and November 1st and specifies general best management practices and other requirements for work in these areas.

Project plans should include implementation of temporary erosion controls in accordance with local standards of practice. Control methods should include use of perimeter silt fences, and straw mulch in exposed areas. Removal of existing vegetation should be limited to those areas that are required to construct the project, and new landscaping and vegetation with equivalent erosion mitigation potential should be established as soon as possible after grading is complete. During construction, surface water should be collected as close as possible to the source to minimize silt entrainment that could require treatment or detention prior to discharge. Timely implementation of permanent drainage control measures should also be a part of the project plans and will help reduce erosion and generation of silty surface water onsite.

III. PRELIMINARY DESIGN RECOMMENDATIONS

8.0 INTRODUCTION

Our exploration indicates that, from a geotechnical engineering standpoint, the proposed project is feasible provided the recommendations contained herein are properly followed. Conventional spread footing foundations may be used for building support. The depth to suitable foundation bearing soils encountered in the explorations located in the proposed building areas generally ranged from approximately 1 to 5 feet.

9.0 SITE PREPARATION

Site preparation of building and paving areas should include removal of all sod, trees, brush, debris, pavement, and any other deleterious materials. All existing fill beneath planned foundation areas should be removed. Any remaining foundation elements, buried utilities, or other structures should be removed from below planned foundation areas. Buried utilities should be abandoned in place or removed from below planned new paving. Any depressions below planned final grades caused by demolition activities should be backfilled with structural fill, as discussed under the "Structural Fill" section of this report.

Existing topsoil should be stripped from all structural areas. The actual observed in-place depth of forest duff and topsoil at the locations of the explorations ranged from approximately 6 inches to 2 feet. After stripping, remaining roots and stumps should be removed from structural areas. All soils disturbed by stripping and grubbing operations should be recompacted as described below for structural fill.

Once excavation to subgrade elevation is complete, the resulting surface should be recompacted to a firm and unyielding condition. Subgrades below pavement areas should be proof-rolled with a loaded dump truck or other suitable equipment. Any soft, loose, yielding areas or areas exposing excessively organic material should be excavated to expose suitable bearing soils. The subgrade should then be compacted to a firm and unyielding condition. Structural fill can then be placed to achieve desired grades, if needed.

9.1 Temporary Cut Slopes

In our opinion, stable construction slopes should be the responsibility of the contractor and should be assessed during construction. For estimating purposes, however, temporary, unsupported cut slopes can be planned at maximum inclinations of 1.5H:1V in unsaturated existing fill or loose to medium dense, weathered glacial sediments or weathered bedrock-derived soils. Temporary slopes of up to 1H:1V can be planned in the unsaturated, dense to very dense, unweathered glacial sediments or weathered bedrock.

The recommended temporary cut slope angles apply where groundwater seepage is not present at the faces of the slopes. If seepage is present where temporary excavation slopes are exposed, flatter slope angles may be recommended. Alternatively, temporary dewatering in the form of pumped sumps or other measures may be recommended. As is typical with earthwork operations, some sloughing and raveling may occur, and cut slopes may have to be adjusted in the field. In addition, WISHA/OSHA regulations should be followed at all times.

9.2 Site Disturbance

The on-site soils contain high percentages of fine-grained material, which makes them moisture-sensitive and subject to disturbance when wet. The contractor must use care during site preparation and excavation operations so that the underlying soils are not softened. If disturbance occurs, the softened soils should be removed and the area brought to grade with structural fill.

9.3 Winter Construction

The existing fill material, natural glacial sediments, and weathered bedrock generally contain high percentages of silt and are considered highly moisture-sensitive. Some of these materials may require drying during favorable dry weather conditions to allow their reuse in structural fill applications. Care should be taken to seal all earthwork areas during mass grading at the end of each workday by grading all surfaces to drain and sealing them with a smooth-drum roller. Stockpiled soils that will be reused in structural fill applications should be covered whenever precipitation is anticipated.

If winter construction is expected, crushed rock fill could be used to provide construction staging areas where exposed soil is present. The stripped subgrade should be observed by the geotechnical engineer, and should then be covered with a geotextile fabric, such as Mirafi 500X or equivalent. Once the fabric is placed, we recommend using a crushed rock fill layer at least 10 inches thick in areas where construction equipment will be used.

10.0 STRUCTURAL FILL

All references to structural fill in this report refer to subgrade preparation, fill type, placement, and compaction of materials, as discussed in this section. If a percentage of compaction is specified under another section of this report, the value given in that section should be used.

For backfill of buried utilities in the right-of-way, the backfill should be placed and compacted in accordance with the City of Issaquah codes and standards.

After stripping, planned excavation, and any required overexcavation has been performed to the satisfaction of the geotechnical engineer/engineering geologist, the surface of the exposed ground should be recompacted to a firm and unyielding condition. If the subgrade contains too much moisture, adequate recompaction may be difficult or impossible to achieve, and should probably not be attempted. In lieu of recompaction, the area to receive fill should be blanketed with washed rock or quarry spalls to act as a capillary break between the new fill and the wet subgrade. Where the exposed ground remains soft and further overexcavation is impractical, placement of an engineering stabilization fabric may be necessary to prevent contamination of the free-draining layer by silt migration from below.

After recompaction of the exposed ground is approved, or a free-draining rock course is laid, structural fill may be placed to attain desired grades. Structural fill is defined as non-organic soil, acceptable to the geotechnical engineer, placed in maximum 8-inch loose lifts, with each lift being compacted to 95 percent of ASTM D-1557. The top of the compacted fill should extend horizontally outward a minimum distance of 3 feet beyond the locations of the perimeter footings or roadway edges before sloping down at a maximum angle of 2H:1V. Extending the fill beyond the footing edge provides subgrade conditions consistent with anticipated footing pressure distribution.

The contractor should note that any proposed fill soils should be evaluated by AESI prior to their use in fills. This would require that we have a sample of the material at least 72 hours in advance to perform a Proctor test and determine its field compaction standard.

Soils in which the amount of fine-grained material (smaller than the No. 200 sieve) is greater than approximately 5 percent (measured on the minus No. 4 sieve size) should be considered moisture-sensitive. The sediments encountered in our explorations contain substantially more than 5 percent fine-grained material. The use of moisture-sensitive soil in structural fills should be limited to favorable dry weather and dry subgrade conditions. Construction equipment traversing the site when the soils are wet can cause considerable disturbance.

If fill is placed during wet weather or if proper compaction cannot be attained, a select, import material consisting of a clean, free-draining gravel and/or sand should be used. Free-draining fill consists of non-organic soil, with the amount of fine-grained material limited to 5 percent by weight when measured on the minus No. 4 sieve fraction, and at least 25 percent retained on the No. 4 sieve.

Excavated existing fill is suitable for reuse in structural fill applications if such reuse is specifically allowed by project plans and specifications, if it is free of excessive organic debris and other deleterious materials, and the moisture content is at or adjusted to a level suitable to achieve the specified level of compaction. Portions of the sediments encountered in our explorations exhibited moisture contents above the optimum for achieving suitable compaction. These sediments are described as "very moist" on the exploration logs in Appendix A. Soil moisture conditions should be expected to vary with location, depth, weather conditions, season, and other factors. If the moisture content of the excavated on-site soils proposed for reuse in structural fill applications is high at the time of construction, they could be moisture-conditioned by drying during favorable dry weather conditions. Alternatives to drying site soils include treating the soil with Portland cement or using imported granular soils with moisture contents suitable for achieving the specified compaction.

10.1 Controlled Low-Strength Material

Controlled low-strength material, also known as controlled density fill or "CDF," is normally specified in terms of its compressive strength, which typically ranges from approximately 50 to 200 pounds per square inch (psi). CDF having a strength of 50 psi (7,200 pounds per square foot [psf]), provides adequate support for most structural applications and can be readily excavated with hand shovels and other non-mechanized tools. A strength of 100 psi (14,400 psf) provides additional support for special applications, but greatly increases the difficulty of hand excavation. In general, CDF with a strength greater than about 100 psi requires power equipment to excavate and therefore should not be used in areas where future hand excavation may be needed. CDF may be used in lieu of structural fill for this project. However, in those areas where CDF will be used below footings with an allowable bearing pressure exceeding 3,000 psf, we recommend that the CDF have a minimum compressive strength of 200 psi.

11.0 FOUNDATIONS

Conventional continuous footings and column pads may be used for building support when founded either directly on the undisturbed, medium dense to very dense natural sediments, or on structural fill placed over these materials. We recommend that an allowable foundation soil bearing pressure of 3,000 psf be used for design purposes, including both dead and live loads. An allowable bearing pressure of 6,000 psf may be used where foundations bear directly on the dense to very dense, unweathered glacial sediments or bedrock. In most areas of the site, dense to very dense sediments/bedrock were encountered in our explorations at depths of approximately 1 to 5 feet. However, dense natural sediments were encountered at depths of up to approximately 10 to 15 feet in a few locations. An increase in the allowable bearing pressure of one-third may be used for short-term wind or seismic loading. If structural fill is placed below footing areas, the structural fill should extend horizontally beyond the footing edges. For a footing supported on a structural fill bearing pad, this distance should be equal to or greater than the thickness of the fill pad. This requirement does not apply to footings supported on a large mass fill such as behind a tall retaining wall.

All footings must penetrate to the prescribed bearing stratum and no footing should be founded in or above loose, organic, or existing fill soils. It should be noted that the area bounded by lines extending downward at 1H:1V from any footing must not intersect another footing or filled area. In addition, a 1.5H:1V line extending down from any footing must not daylight because sloughing or raveling may eventually undermine the footing. Thus, footings should not be placed near the edge of steps or cuts in the bearing soils.

We recommend using a modulus of subgrade reaction equal to 40 pounds per cubic inch (pci) for footings designed for an allowable bearing pressure of 3,000 psf and a modulus of subgrade reaction equal to 80 pci for footings designed for an allowable bearing pressure of 6,000 psf. Anticipated settlement of footings founded on suitable bearing soils should be less than 1 inch with differential settlement one-half of the anticipated total settlement. Most of this movement should occur during initial dead load applications. However, disturbed soil not removed from footing excavations prior to concrete placement could result in increased settlements. All footing areas should be observed by AESI prior to placing concrete to verify that the design bearing capacity of the soils has been attained and that construction conforms to the recommendations contained in this report. Such observation may be required by the City of Issaquah. Perimeter foundation drain systems should be provided as discussed under the "Drainage Considerations" section of this report.

The contractor must use care during site preparation and excavation operations so that the underlying soils are not softened. If disturbance occurs, the softened soils should be removed and foundations extended down to competent natural soil. Once the base of the excavation is reached, consideration should be given to "armoring" the exposed subgrade with a thin layer of imported aggregate to provide a working surface during foundation construction. We recommend a 6-inch layer of crushed rock for this purpose.

11.1 Drainage Considerations

All building and retaining wall foundations should be provided with foundation drains. Drains should consist of rigid, perforated, polyvinyl chloride (PVC) pipe surrounded by washed gravel. The drains should be constructed with sufficient gradient to allow gravity discharge away from the proposed building. Roof and surface runoff should not discharge into the footing drain system, but should be handled by a separate, rigid, tightline drain. In planning, exterior grades adjacent to walls should be sloped downward away from the proposed structures to achieve surface drainage.

12.0 FLOOR SUPPORT

Slab-on-grade floors may be constructed either directly on the medium dense to dense, natural sediments, or on structural fill placed over these materials. Areas of the slab subgrade that are disturbed (loosened) during construction should be recompacted to an unyielding condition prior to placing the capillary break, as described below. Slab-on-grade floors should be constructed atop a capillary break consisting of a minimum thickness of 4 inches of washed pea gravel or washed, crushed rock. The washed pea gravel or crushed rock should be overlain by a 10-mil (minimum thickness) plastic vapor retarder.

13.0 FOUNDATION WALLS

The following preliminary recommendations may be applied to backfilled concrete retaining walls up to 8 feet tall. We should be allowed to offer situation-specific input for taller walls. All backfill behind foundation walls or around foundation units should be placed as per our recommendations for structural fill and as described in this section of the report. Horizontally backfilled walls, which are free to yield laterally at least 0.1 percent of their height, may be designed to resist lateral earth pressure represented by an equivalent fluid equal to 35 pounds per cubic foot (pcf). Fully restrained, horizontally backfilled, rigid walls that cannot yield should be designed for an equivalent fluid of 50 pcf. Walls with sloping backfill up to a maximum gradient of 2H:1V should be designed using an equivalent fluid of 55 pcf for yielding conditions or 75 pcf for fully restrained conditions. If parking areas are adjacent to walls, a surcharge equivalent to 2 feet of soil should be added to the wall height in determining lateral design forces.

As required by the 2015 IBC, retaining wall design should include a seismic surcharge pressure in addition to the equivalent fluid pressures presented above. Considering the site soils and the recommended wall backfill materials, we recommend a seismic surcharge pressure of 9H and 11H psf, where H is the wall height in feet for the “active” and “at-rest” loading conditions, respectively. The seismic surcharge should be modeled as a rectangular distribution with the resultant applied at the midpoint of the walls.

The lateral pressures presented above are based on the conditions of a uniform backfill consisting of excavated on-site soils, or imported structural fill compacted to 90 to 95 percent of ASTM D-1557. A higher degree of compaction is not recommended, as this will increase the pressure acting on the walls. A lower compaction may result in settlement of the slab-on-grade or other structures supported above the walls. Thus, the compaction level is critical and must be tested by our firm during placement. Surcharges from adjacent footings or heavy construction equipment must be added to the above values. Perimeter footing drains should be provided for all retaining walls, as discussed under the "Drainage Considerations" section of this report.

It is imperative that proper drainage be provided so that hydrostatic pressures do not develop against the walls. This would involve installation of a minimum 1-foot-wide blanket drain to within 1 foot of finish grade for the full wall height using imported, washed gravel against the walls.

13.1 Passive Resistance and Friction Factors

Lateral loads can be resisted by friction between the foundation and the natural soils or supporting structural fill soils, and by passive earth pressure acting on the buried portions of the foundations. The foundations must be backfilled with structural fill and compacted to at least 95 percent of the maximum dry density to achieve the passive resistance provided below. We recommend the following allowable design parameters:

- Passive equivalent fluid = 300 pcf
- Coefficient of friction = 0.35

14.0 PAVEMENT RECOMMENDATIONS

14.1 Flexible Pavement

The project will include construction of new asphalt-paved surfaces in the form of parking lots, access drives, and bus loops. Pavement recommendations for these areas are provided below. The project will also include widening and other improvements in 228th Avenue SE. Pavement design for the 228th Avenue SE improvements is being assessed and pavement recommendations for this area will be provided in a separate report.

After the area to be paved is stripped, any organic soils are removed, and the soils are recompacted, the area should be proof-rolled with a loaded dump truck under the observation of AESI. Any soft, wet, organic, or yielding areas should be mitigated as recommended during construction. If warranted, engineering stabilization fabric, such as Mirafi 500X (or equivalent), should be placed over the subgrade with the edges overlapped in accordance with the manufacturer's recommendations. Following subgrade preparation, clean, free-draining structural fill should be placed over the fabric and compacted to 95 percent of ASTM D-1557. Where fabric is exposed, spreading should be performed such that the dozer remains on the fill material and is not allowed to operate directly on the uncovered fabric. When 12 inches of fill has been placed, the fill should be proof-rolled with a loaded dump truck to pretension the fabric and identify soft spots in the fill. Upon completing the proof-rolling operation, additional structural fill should be placed and compacted to attain desired grades.

For driveways and paving serving passenger cars, we recommend a paving section consisting of 3 inches of Class ½-inch Hot Mix Asphalt (HMA) underlain by 4 inches of crushed surfacing base course (CSBC). Alternatively, asphalt treated base (ATB) or Class ¾-inch HMA could be used for construction access followed by repair of any construction damage and final surfacing. If this alternative is used, we recommend a minimum of 2 inches of CSBC to serve as a working surface and a minimum of 3 inches of ATB. Final surfacing should consist of 2 inches of Class ½-inch HMA after any construction damage has been repaired.

Paving for heavy traffic areas such as bus lanes, fire lanes, and access for garbage and food service trucks should consist of 4 inches of Class ½-inch HMA above 6 inches of crushed rock base. If an ATB section is desired, we recommend a 2-inch-thick working surface of crushed rock, topped by 4 inches of ATB and 3 inches of Class ½-inch HMA.

14.2 Rigid Pavement

Project plans include the use of rigid concrete pavement at loading docks, in the fire lane east of the high school, and in the student drop-off area in front of the high school. Upon completion of the subgrade preparation as described above for flexible pavement, we recommend the following rigid pavement sections:

- Student Drop-Off Area

  6 inches - Portland Cement Concrete (PCC)
  4 inches - Compacted, 1¼-inch minus crushed surfacing base course

- Loading Dock and Fire Lane Areas

  7 inches - Portland Cement Concrete (PCC)
  4 inches - Compacted, 1¼-inch minus crushed surfacing base course

The base course material should be compacted to 95 percent of maximum dry density as defined by ASTM D-1557.

All concrete should have a minimum of six sacks of cement per cubic yard, a minimum 28-day compressive strength of 4,000 psi, and a minimum 28-day flexural strength of 650 psi. We further recommend that all concrete contain 5 percent entrained air for freeze-thaw protection, and be placed at a maximum 2½-inch slump. The wear surface should be textured with a coarse metal broom or rake finish to provide skid resistance.

To allow for an orderly arrangement of the cracking that concrete naturally undergoes during curing, we recommend placement of contraction joints. The depth of the joints should be sawed into the hardened concrete, formed by plastic strips, or tooled into the concrete during placement. Contraction joints should be placed at a maximum of 15-foot intervals. If rigid pavement is to be used for covering broad expanses, contraction joints should be placed on a 15-foot grid pattern.

Expansion joints should be installed at 60-foot intervals along the fire lane. These joints will also function as contraction joints. The expansion joints should be ¾ inch wide. All expansion joints should be filled with suitable filler material.

Load transfer dowels should be installed perpendicular to all pavement expansion joints. These dowels should be ¾-inch-diameter (No. 6), smooth bars, 18 inches in length, thus allowing 9 inches of penetration on each side of the joint. Load transfer dowels should be spaced 12 inches on-center and be set 3 inches below the concrete surface. Suitable wire mesh reinforcement, properly placed (and properly maintained during construction) in the upper one-third of the slab, should also be provided for all concrete pavements.

15.0 ATHLETIC FIELD DESIGN AND CONSTRUCTION

We understand that the new athletic field for the high school will have a synthetic turf surface and lighting.

AESI has participated in construction of numerous synthetic turf athletic fields in western Washington. In our opinion, synthetic turf projects are very specialized, and should be designed by a specialty field designer with demonstrated experience designing and construction managing synthetic turf athletic fields in Western Washington. The recommendations presented below include geotechnical recommendations directed to the field designer. We are available on request to assist the field designer as plans are formulated.

15.1 Athletic Field Site Preparation

We recommend that the surface of the subgrade soils exposed during grading be compacted with a smooth-drum, vibratory roller to at least 90 percent of the modified Proctor maximum dry density, as determined by the ASTM D-1557 test procedure, and to a firm and unyielding surface. When stripping and excavation are completed, we anticipate that exposed soils will consist of existing fill or lodgement till. If areas of existing fill with excessive organic material or demolition waste are exposed after rough grading, it may be appropriate to overexcavate these materials and replace them with suitable fill. We recommend that project bid documents include some overexcavation and replacement of subgrade soils in the base bid, and equitable unit costs for volumes more or less than the base bid. A base bid volume of overexcavation and replacement of 200 cubic yards might be appropriate based on subsurface exploration data. We recommend that volumes of overexcavation and replacement be defined in terms of bank cubic yards, with unit costs volumes based on before and after survey data. The District should be aware that the 200-cubic-yard figure is an estimate, and is used to establish an equitable base bid and unit cost structure that is flexible and able to address field conditions that will not be fully known until the time of construction. We recommend that the District carry a budget contingency for additional overexcavation and replacement beyond what is included in the base bid.

Following stripping, any organic material removal, replacement, and recompaction, all athletic field and track subgrades should be proof-rolled using a loaded dump truck or other suitable equipment under the observation of the geotechnical engineer. If soft or yielding areas are observed during proof-rolling, additional preparation might be required. Depending upon field conditions at the time of construction, additional preparation could include overexcavation and replacement of yielding soils with structural fill, use of a geotextile fabric, soil cement admixture stabilization, or some combinations of these methods. The amount of overexcavation will depend on the time of year construction occurs, the amount of precipitation during this time, and the amount of care the contractor takes in protecting the exposed subgrade.

The on-site soils contain a significant amount of fine-grained material, which makes them moderately moisture-sensitive and subject to disturbance when wet. The contractor must use care during site preparation and excavation operations so that the underlying soils are not softened. If disturbance occurs, the softened soils should be removed and the area brought to grade with structural fill. It should be noted that the moisture content of the site soils was visually estimated to typically be near or above the optimum moisture content for compaction purposes at the time of our study. It will likely be necessary to aerate site soils during favorable dry weather to reach suitable moisture contents prior to compaction.

15.2 Athletic Field Cut and Fill Slopes

In our opinion, stable construction slopes should be the responsibility of the contractor and should be determined during construction. For estimating purposes, however, we anticipate that temporary, unsupported cut slopes in the existing fill can be made at a maximum slope of 1.5H:1V or flatter. Temporary slopes in unsaturated lodgement till may be planned at 1H:1V. As is typical with earthwork operations, some sloughing and raveling may occur, and cut slopes may have to be adjusted in the field. If groundwater seepage is encountered in cut slopes, or if surface water is not routed away from temporary cut slope faces, flatter slopes will be required. In addition, WISHA/OSHA regulations should be followed at all times. Permanent cut and structural fill slopes that are not intended to be exposed to surface water should be designed at inclinations of 2H:1V or flatter. All permanent cut or fill slopes should be compacted to at least 95 percent of the modified Proctor maximum dry density, as determined by ASTM D-1557, and the slopes should be protected from erosion by sheet plastic until vegetation cover can be established during favorable weather.

15.3 Athletic Field Structural Fill

Fill Placement

After athletic field stripping, excavation, and any required overexcavation have been performed to the satisfaction of the geotechnical engineer/engineering geologist, the upper 12 inches of exposed ground should be recompacted to 90 percent of the modified Proctor maximum density using ASTM D-1557 as the standard. If the subgrade contains too much moisture, adequate recompaction may be difficult or impossible to obtain and should probably not be attempted. In lieu of recompaction, the area to receive fill should be blanketed with washed rock or quarry spalls to act as a capillary break between the new fill and the wet subgrade. Where the exposed ground remains soft and further overexcavation is impractical, placement of an engineering stabilization fabric may be necessary to prevent contamination of the free-draining layer by silt migration from below.

After recompaction of the exposed ground is tested and approved, or a free-draining rock course is laid, structural fill may be placed to attain desired grades. Structural fill is defined as non-organic soil, acceptable to the geotechnical engineer, placed in maximum 8-inch loose lifts, with each lift being compacted to 90 percent of the modified Proctor maximum density using ASTM D-1557 as the standard. In the case of utility trench filling, the backfill may also need to be placed and compacted in accordance with current local codes and standards. The top of the compacted fill should extend horizontally outward a minimum distance of 3 feet beyond the locations of athletic field and pavement edges before sloping down at a maximum angle of 2H:1V.

The contractor should note that any proposed fill soils must be evaluated by AESI prior to their use in fills. This would require that we have a sample of the material 72 hours in advance of filling activities to perform a Proctor test and determine its field compaction standard. Soils in which the amount of fine-grained material (smaller than the No. 200 sieve) is greater than approximately 5 percent (measured on the minus No. 4 sieve size) should be considered moisture-sensitive. Use of moisture-sensitive soil in structural fills should be limited to favorable dry weather conditions. The on-site existing fill and native sediments contain significant amounts of silt and are considered highly moisture-sensitive. We anticipate that most of the existing soils will be wetter than optimum moisture content for compaction purposes and will require drying during favorable dry site and weather conditions prior to reuse in structural fill applications. The reuse of on-site soils in structural fill applications is contingent on moisture-conditioning to a moisture content that allows compaction to a firm and unyielding condition at the specified level, and is only permitted if specifically allowed by project plans and specifications.

Construction equipment traversing the site when the soils are wet can cause considerable disturbance. If fill is placed during wet weather or if proper compaction cannot be obtained, a select import material consisting of a clean, free-draining gravel and/or sand should be used. Free-draining fill consists of non-organic soil with the amount of fine-grained material limited to 5 percent by weight when measured on the minus No. 4 sieve fraction with at least 25 percent retained on the No. 4 sieve.

15.4 Subsurface Drains (Underdrains)

We recommend that a subsurface drainage system be provided below the new field. The new underdrain system should consist of perforated pipes placed approximately 15 to 20 feet apart. The pipes should have an invert of at least 12 inches below final grade and be enveloped in washed pea gravel which freely communicates with the field surfacing. We defer to the field designer for specific underdrain requirements and are available to provide geotechnical recommendations related to underdrain design on request.

Subsurface Drain Trenching

Based on current grading plans, field elevation will be approximately elevation 509 feet. To achieve the planned field elevation fills ranging from 3 to 8 feet or cuts of about 2 feet will be required. Construction of the subsurface drains will require trenching into the new fill or lodgement till. The new fill soils within the proposed athletic field area will be medium dense to dense while the lodgement till will be medium dense to very dense. The lodgement till could contain gravel, cobbles and boulders. Therefore, the contractor should be prepared to excavate dense soils and to encounter gravel, cobbles, and occasional boulders during trenching.

15.5 Subfield Drainage Aggregate

We anticipate that two layers of drainage aggregate will be placed and compacted over the prepared field subgrade and below the turf. The drainage aggregate is a very specialized manufactured product that provides a compactable, stable working surface while maintaining a high minimum infiltration rate. Ideally, the aggregate should be sourced from a supplier who has demonstrated experience providing synthetic field drainage aggregate on previous projects. The drainage aggregate should be tested for gradation and approved by the field designer prior to delivery onsite. Daily sampling and gradation testing during placement is recommended. The material should be kept moist during transport, placement, and compaction to reduce the potential for fines segregation. Once placed and compacted, the material should be field tested for density and permeability. If field permeability test results are below the minimum project requirements, the material may need to be loosened and recompacted or removed and replaced with materials that meet the minimum permeability requirements.

15.6 Athletic Field Light Pole Foundations

We understand that light pole foundations for this project will consist of concrete piers cast neat against the sidewalls of drilled holes without the use of forms.

Compressive Capacities

For this project, we anticipate that lateral capacities will be the most critical design factor for the light pole foundations, and will likely exert the most control over the depth of embedment. We recommend that the end-bearing portion of the axial compressive capacity be assumed to be 500 psf for light poles embedded at least 5 feet below the ground surface into new structural fill, existing fill or lodgement till. Vertical capacity can also be achieved through friction along the shafts of the poles, as described below.

Frictional Resistance

For frictional resistance along the shaft of the drilled piers used for light pole foundations, acting both in compression and in uplift, an allowable skin friction value of 250 psf for the existing fill, new structural fill or lodgement till is recommended. We recommend that frictional resistance be neglected in the uppermost 2 feet below the ground surface. The allowable skin friction value includes a safety factor of at least 2.0.

Lateral Capacities

Passive Pressure Method

Lateral loads on the proposed light pole foundations, caused by seismic or transient loading conditions, may be resisted by passive soil pressure against the side of the foundation. An allowable passive earth pressure of 200 pcf, expressed as an equivalent fluid unit weight, may be used for that portion of the foundation embedded within existing fill. The above values only apply to foundation elements cast "neat" against undisturbed soil. For new structural fill placed around the pier shaft or lodgement till, a passive earth pressure value of 250 pcf is recommended. All fill must be placed as structural fill and compacted to at least 95 percent of ASTM D-1557. Passive values presented may be represented by a triangular pressure distribution acting over two pier diameters beginning at the surface and held at a constant depth greater than 8 feet. The triangular pressure distribution is truncated above 2 feet.

Light Pole Foundation Construction Considerations

In our opinion, the light pole foundation excavations may need to be cased during drilling within fill soils to facilitate construction and limit caving. The contractor should include temporary casing for the light pole foundation holes in their base bid, in our opinion. The contractor should have the ability to excavate and remove obstacles encountered during light pole foundation drilling, or light pole locations should be shifted to avoid obstacles that are encountered.

16.0 INFILTRATION FEASIBILITY

Because of their high percentage of fine-grained material and high relative density, the lodgement till and Blakely Harbor Formation bedrock are not recommended receptor soils for stormwater infiltration. Exploration boring EB-11, located in the central portion of the site, was drilled to a maximum depth of approximately 86 feet to assess the feasibility of deep infiltration. With the exception of a thin sand stratum encountered in this boring at a depth of approximately 30 feet, the sediments encountered in boring EB-11 consisted of dense, silty deposits. Because of their high relative density/consistency and elevated silt content, these sediments exhibit a low permeability and are not considered suitable receptor soils for stormwater infiltration. The sand stratum encountered at a depth of approximately 30 feet in boring EB-11 was estimated to be about 4 feet thick. In addition, this stratum was not encountered in any of the other explorations advanced at the site. Because of its limited thickness and lateral extent, it is our opinion that this sand stratum is not a suitable receptor soil for stormwater infiltration. Due to the lack of suitable infiltration receptor soils at the site, on-site stormwater infiltration is not recommended for this project. Exploration boring EB-11 was terminated in the Blakely Harbor Formation bedrock.

17.0 PROJECT DESIGN AND CONSTRUCTION MONITORING

Because project plans were not available at the time of our study, this report is considered to be preliminary. We recommend that we be allowed to review project plans when they are completed and to revise the recommendations presented in this report, if appropriate.

We are also available to provide geotechnical engineering and monitoring services during construction. The integrity of the foundation system depends on proper site preparation and construction procedures. In addition, engineering decisions may have to be made in the field in the event that variations in subsurface conditions become apparent.

We have enjoyed working with you on this study and are confident these recommendations will aid in the successful completion of your project. If you should have any questions or require further assistance please do not hesitate to call.

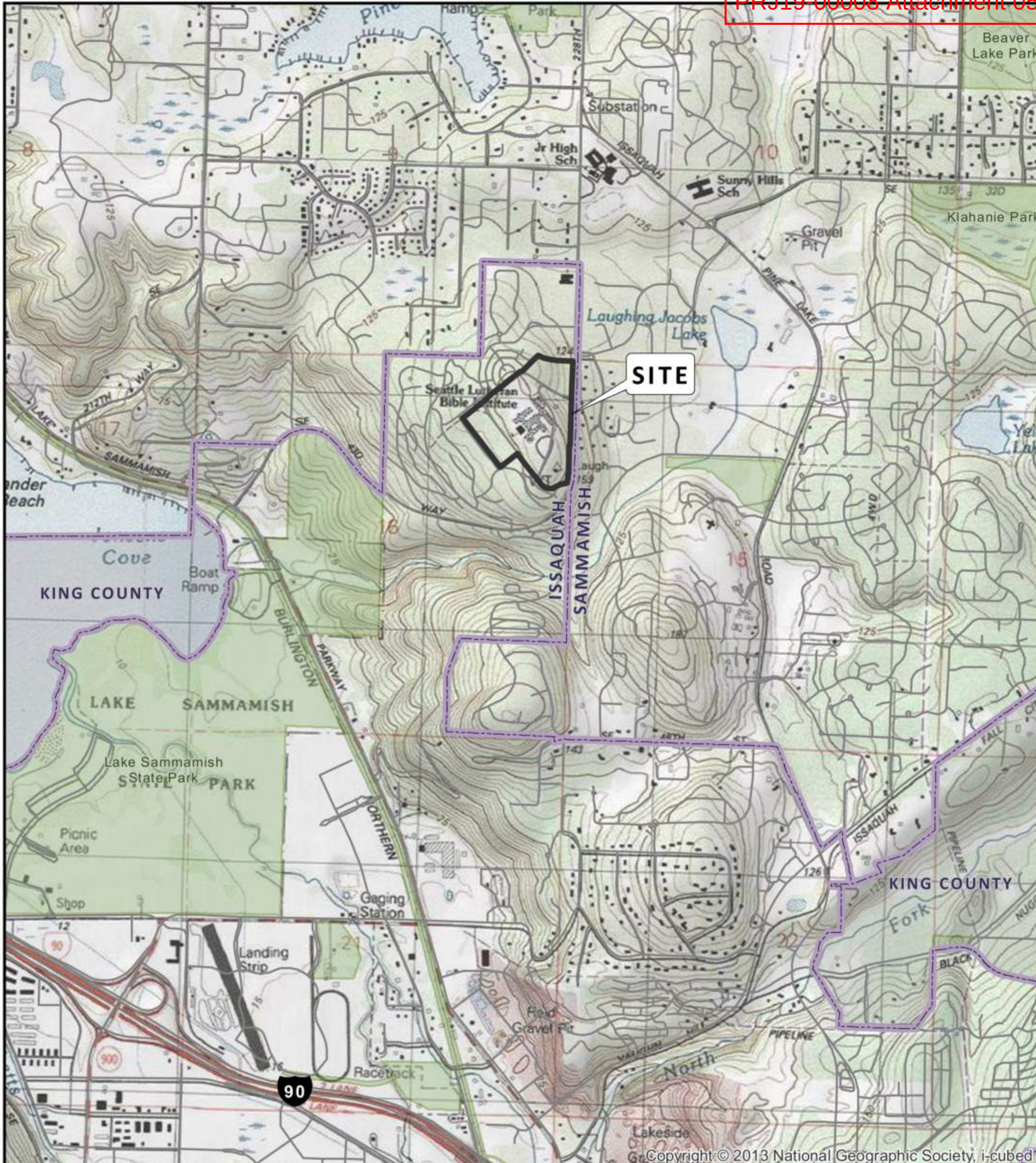
Sincerely,
ASSOCIATED EARTH SCIENCES, INC.
Kirkland, Washington

Timothy J. Peter, L.E.G., L.Hg.
Senior Engineering Geologist

Stephen A. Siebert, P.E.
Associate Geotechnical Engineer

Kurt D. Merriman, P.E.
Senior Principal Engineer

Attachments:	Figure 1:	Vicinity Map
	Figure 2:	2017 Aerial, LIDAR Based Contours
	Figure 3:	Site and Exploration Plan
	Figure 4:	Steep Slope Areas
	Figure 5:	LIDAR Shaded Relief Map
	Appendix A:	Exploration Logs
	Appendix B:	SLOPE/W Profiles



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VICINITY MAP

ISSAQUAH HS #4 AND ES #17
ISSAQUAH, WASHINGTON

DATA SOURCES / REFERENCES:
USGS: 7.5' SERIES TOPOGRAPHIC MAPS, ESRI/I-CUBED/NGS 2013
KING CO: STREETS, CITY LIMITS 1/18, PARCELS 8/18

LOCATIONS AND DISTANCES SHOWN ARE APPROXIMATE

NOTE: BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION

PROJ NO.	DATE:	FIGURE:
180070E001	9/19	1

Document Path: G:\GIS_Projects\aaY2018\180070\180070 Issaquah HS\mxd\180070E001 F1 VM_IssaquahHS.mxd

SITE
EXPLORATION BORING
EXPLORATION PIT
TEST PIT BY EARTH SOLUTIONS NW, 2014
TEST PIT BY TERRA ASSOCIATES INC., 2015
PARCEL
CONTOUR 20 FT
CONTOUR 5 FT

NOTE:
IMAGE TAKEN PRIOR TO DEMOLITION OF EXISTING STRUCTURES.
DEMO IN PROCESS DEC. 2018 AND DONE BY JUNE 2019.

DATA SOURCES / REFERENCES:
PSLC: KING COUNTY 2016, GRID CELL SIZE IS 3'.
DELIVERY 3 FLOWN 3/2/16 - 3/29/16.
CONTOURS FROM LIDAR
KING CO: STREETS, 1/19, PARCELS 4/19, AERIAL PICTOMETRY INT. 2017
TEST PITS FROM: "GEOTECHNICAL REPORT MADISON POINTE", BY TERRA ASSOCIATES 11/14/2018

LOCATIONS AND DISTANCES SHOWN ARE APPROXIMATE

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0 125 250
FEET

BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION

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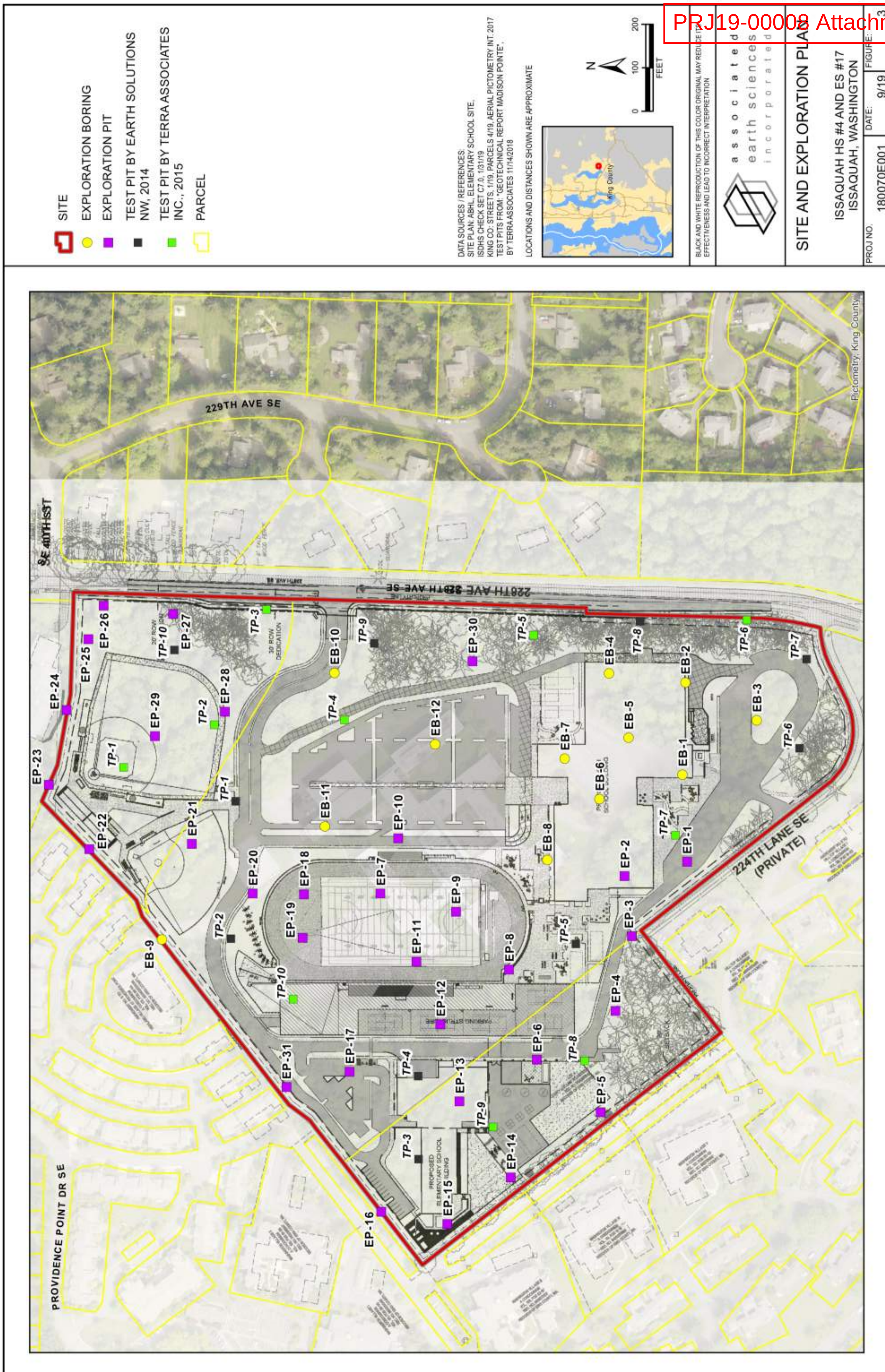
2017 AERIAL
LIDAR BASED CONTOURS
ISSAQUAH HS #4 AND ES #17
ISSAQUAH, WASHINGTON

PROJ NO.	DATE:	FIGURE:
180070E001	9/19	2

Document Path: G:\GIS_Projects\aaY2018\180070 Issaquah HS\mxd\180070E001 F2 ESP_IssaquahHS.mxd

Figure 6-1


SITE
EXPLORATION BORING
EXPLORATION PIT
TEST PIT BY EARTH SOLUTIONS NW, 2014
TEST PIT BY TERRA ASSOCIATES INC., 2015
PARCEL
DATA SOURCES / REFERENCES:
SITE PLAN: ABHL, ELEMENTARY SCHOOL SITE, ISDHS CHECK SET C7.0, 1/31/19
KING CO: STREETS, 1/19, PARCELS 4/19, AERIAL PICTOMETRY INT. 2017
TEST PITS FROM: "GEOTECHNICAL REPORT MADISON POINTE", BY TERRA ASSOCIATES 11/14/2018
LOCATIONS AND DISTANCES SHOWN ARE APPROXIMATE
King County
0 100 200
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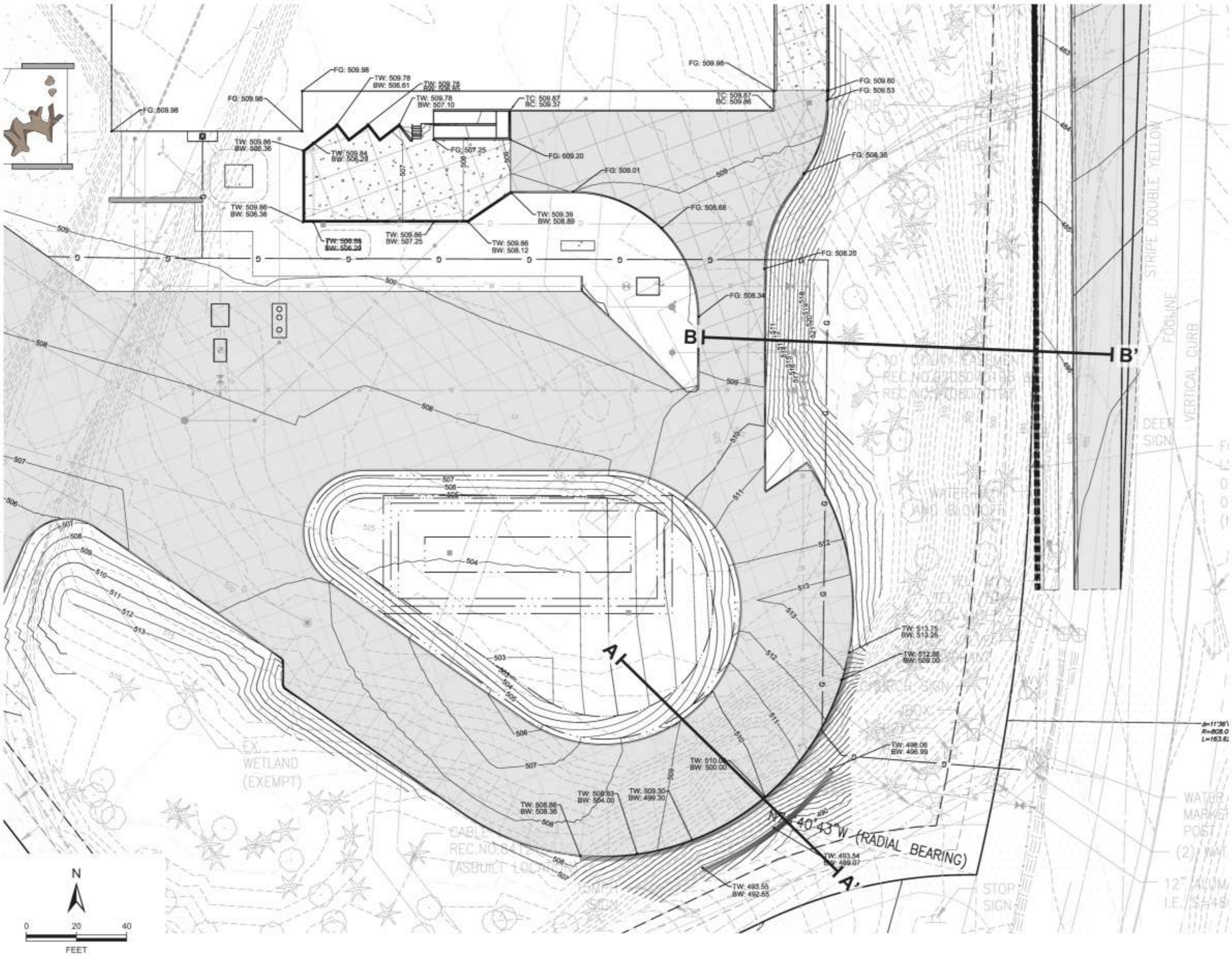
BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION
associated earth sciences incorporated
SITE AND EXPLORATION PLAN
ISSAQUAH HS #4 AND ES #17
ISSAQUAH, WASHINGTON
PROJ NO. 180070E001
DATE: 9/19
FIGURE: 3
229TH AVE SE
228TH AVE SE
SE 40TH ST
224TH LANE SE (PRIVATE)
PROVIDENCE POINT DR SE
Pictometry: King County
EB-1 EB-2 EB-3 EB-4 EB-5 EB-6 EB-7 EB-8 EB-9 EB-10 EB-11 EB-12
EP-1 EP-2 EP-3 EP-4 EP-5 EP-6 EP-7 EP-8 EP-9 EP-10 EP-11 EP-12 EP-13 EP-14 EP-15 EP-16 EP-17 EP-18 EP-19 EP-20 EP-21 EP-22 EP-23 EP-24 EP-25 EP-26 EP-27 EP-28 EP-29 EP-30 EP-31
TP-1 TP-2 TP-3 TP-4 TP-5 TP-6 TP-7 TP-8 TP-9 TP-10
PROPOSED ELEMENTARY SCHOOL BUILDING



LEGEND:

CONTOUR INTERVAL = 1'

NOTE: LOCATION AND DISTANCES SHOWN ARE APPROXIMATE.

NOTES:
1. BASE MAP REFERENCE: AHBL, ISSAQUAH SCHOOL DISTRICT HIGH SCHOOL #4, GRADING PLAN, SHEET C4.7, FINAL DESIGN, 5/20/19

BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION.

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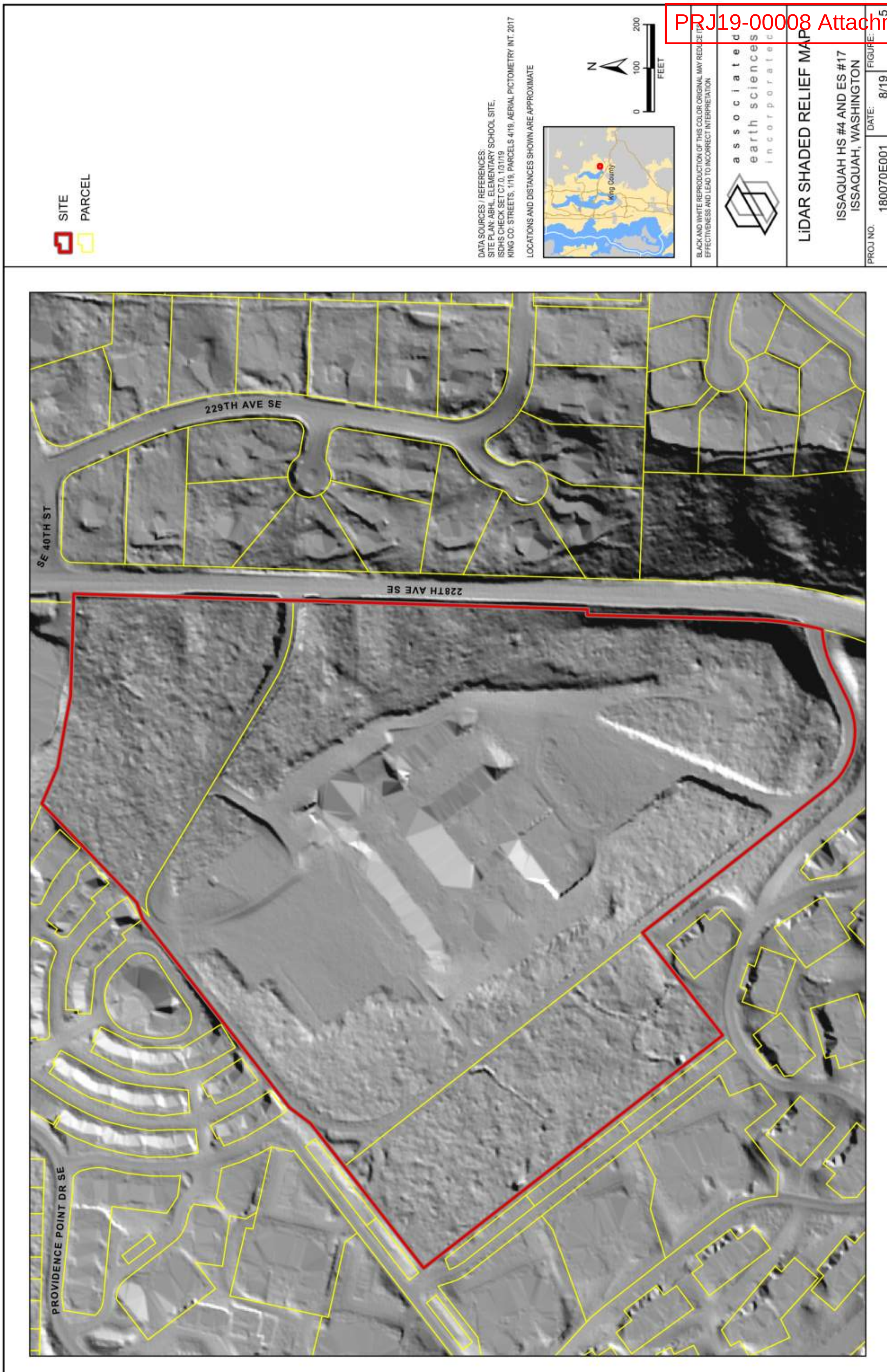
STEEP SLOPE AREAS

ISSAQUAH HS #4 AND ES #17
ISSAQUAH, WASHINGTON

PROJ NO.	DATE:	FIGURE:
180070E001	7/19	4

180070 Issaquah HS \ 180070E001 F4 Slopes. cdr

Figure 6-1



SITE
PARCEL
DATA SOURCES / REFERENCES:
SITE PLAN: ABHL, ELEMENTARY SCHOOL SITE,
ISDHS CHECK SET C7.0, 1/31/19
KING CO: STREETS, 1/19, PARCELS 4/19, AERIAL PICTOMETRY INT. 2017
LOCATIONS AND DISTANCES SHOWN ARE APPROXIMATE
King County
N
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100
200
FEET
BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION
associated earth sciences incorporated
LiDAR SHADED RELIEF MAP
ISSAQUAH HS #4 AND ES #17
ISSAQUAH, WASHINGTON
PROJ NO. 180070E001
DATE: 8/19
FIGURE: 5
229TH AVE SE
SE 40TH ST
228TH AVE SE
PROVIDENCE POINT DR SE
Document Path: G:\GIS_Projects\aaY2018\180070 Issaquah HS\mxd\180070E001 F5 Lidar_IssaquahHS.mxd

APPENDIX A

Exploration Logs

PRJ19-00008 Attachment 054

Major Divisions			Group Symbol	Description
Coarse-Grained Soils - More than 50%[1] Retained on No. 200 Sieve	Gravels - More than 50%[1] of Coarse Fraction Retained on No. 4 Sieve	≤5% Fines[5]	GW	Well-graded gravel and gravel with sand, little to no fines
			GP	Poorly-graded gravel and gravel with sand, little to no fines
		≥12% Fines[5]	GM	Silty gravel and silty gravel with sand
			GC	Clayey gravel and clayey gravel with sand
	Sands - 50%[1] or More of Coarse Fraction Passes No. 4 Sieve	≤5% Fines[5]	SW	Well-graded sand and sand with gravel, little to no fines
			SP	Poorly-graded sand and sand with gravel, little to no fines
		≥12% Fines[5]	SM	Silty sand and silty sand with gravel
			SC	Clayey sand and clayey sand with gravel
Fine-Grained Soils - 50%[1] or More Passes No. 200 Sieve	Silts and Clays Liquid Limit Less than 50		ML	Silt, sandy silt, gravelly silt, silt with sand or gravel
			CL	Clay of low to medium plasticity; silty, sandy, or gravelly clay, lean clay
			OL	Organic clay or silt of low plasticity
	Silts and Clays Liquid Limit 50 or More		MH	Elastic silt, clayey silt, silt with micaceous or diatomaceous fine sand or silt
			CH	Clay of high plasticity, sandy or gravelly clay, fat clay with sand or gravel
			OH	Organic clay or silt of medium to high plasticity
Highly Organic Soils			PT	Peat, muck and other highly organic soils

Terms Describing Relative Density and Consistency

	Density	SPT[2] blows/foot
Coarse-Grained Soils	Very Loose	0 to 4
	Loose	4 to 10
	Medium Dense	10 to 30
	Dense	30 to 50
	Very Dense	>50

	Consistency	SPT[2] blows/foot
Fine-Grained Soils	Very Soft	0 to 2
	Soft	2 to 4
	Medium Stiff	4 to 8
	Stiff	8 to 15
	Very Stiff	15 to 30
	Hard	>30

Test Symbols

G = Grain Size
M = Moisture Content
A = Atterberg Limits
C = Chemical
DD = Dry Density
K = Permeability

Component Definitions

Descriptive Term	Size Range and Sieve Number
Boulders	Larger than 12"
Cobbles	3" to 12"
Gravel	3" to No. 4 (4.75 mm)
Coarse Gravel	3" to 3/4"
Fine Gravel	3/4" to No. 4 (4.75 mm)
Sand	No. 4 (4.75 mm) to No. 200 (0.075 mm)
Coarse Sand	No. 4 (4.75 mm) to No. 10 (2.00 mm)
Medium Sand	No. 10 (2.00 mm) to No. 40 (0.425 mm)
Fine Sand	No. 40 (0.425 mm) to No. 200 (0.075 mm)
Silt and Clay	Smaller than No. 200 (0.075 mm)

[3] Estimated Percentage

Component	Percentage by Weight
Trace	<5
Some	5 to <12
Modifier (silty, sandy, gravelly)	12 to <30
Very *modifier* (silty, sandy, gravelly)	30 to <50

Moisture Content

Dry - Absence of moisture, dusty, dry to the touch

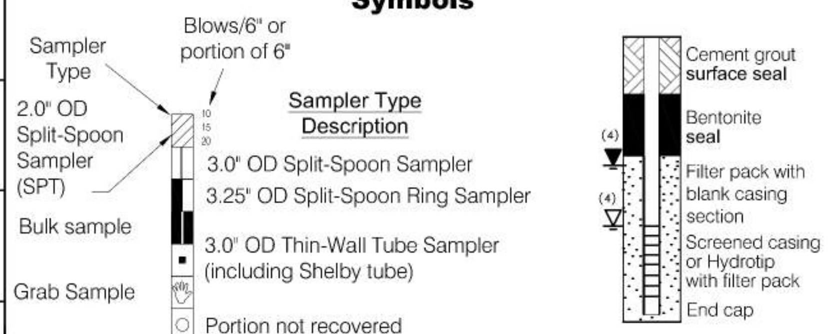
Slightly Moist - Perceptible moisture

Moist - Damp but no visible water

Very Moist - Water visible but not free draining

Wet - Visible free water, usually from below water table

Symbols



(1) Percentage by dry weight
(2) (SPT) Standard Penetration Test (ASTM D-1586)
(3) In General Accordance with Standard Practice for Description and Identification of Soils (ASTM D-2488)
(4) Depth of ground water
▼ ATD = At time of drilling
∇ Static water level (date)
(5) Combined USCS symbols used for fines between 5% and 12%

Classifications of soils in this report are based on visual field and/or laboratory observations, which include density/consistency, moisture condition, grain size, and plasticity estimates and should not be construed to imply field or laboratory testing unless presented herein. Visual-manual and/or laboratory classification methods of ASTM D-2487 and D-2488 were used as an identification guide for the Unified Soil Classification System.

blocks \ dwg \ log_key.dwg LAYOUT: Layout 4 -2014 Qty Chng

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EXPLORATION LOG KEY

FIGURE A1

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Exploration Boring

Project Number	Exploration Number	Sheet
180070E001	EB-1	1 of 1

Project Name	Issaquah HS #4 and ES #17	Ground Surface Elevation (ft)	520
Location	Issaquah, WA	Datum	NAVD 88
Driller/Equipment	Advance Drilling Technology / Track Rig	Date Start/Finish	6/25/19,6/25/19
Hammer Weight/Drop	140# / 30 inches	Hole Diameter (in)	7

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot (10 20 30 40)	Other Tests
				Asphalt - 3.5 inches					
				Vashon Lodgement Till					
		S-1		Moist, grayish tan, gravelly, very silty, SAND; nonstratified (SM).			16 21 12	33	
		S-2		Becomes mottled; some gravel.			7 14 19	33	
5				Contains a lens of gray silt at 5 to 6 feet.					
		S-3		Becomes very moist and gravelly below 6 feet.			6 12 23	35	
				Refusal on a rock at 7.5 feet. Moved over 2.5 feet and resumed drilling.					
10				Becomes gray.					
		S-4					19 22 18	40	
15		S-5					50/4"	50/4"	
				Bottom of exploration boring at 15.5 feet due to refusal. No groundwater encountered.					
20									
25									

Sampler Type (ST):

- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- Water Level ()
- Water Level at time of drilling (ATD)

Logged by: TJP
Approved by: CJK

AESBOR 180070.GPJ August 26, 2019

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Exploration Boring

Project Number	Exploration Number	Sheet
180070E001	EB-2	1 of 1

Project Name	Issaquah HS #4 and ES #17	Ground Surface Elevation (ft)	524
Location	Issaquah, WA	Datum	NAVD 88
Driller/Equipment	Advance Drilling Technology / Track Rig	Date Start/Finish	6/25/19,6/25/19
Hammer Weight/Drop	140# / 30 inches	Hole Diameter (in)	7

Depth (ft)	Samples	DESCRIPTION	Blows/6"	Blows/Foot
		Forest Duff - 4 inches		
	S-1	**Vashon Lodgement Till** Moist, reddish brown, gravelly, very silty, SAND (SM).	6 8 12	20
	S-2	Becomes tan.	6 14 14	28
5	S-3	Blowcounts are likely overstated, pounding on a rock.	50/4"	50/4"
		Difficult drilling.		
10	S-4	Becomes mottled and very gravelly.	20 50/5"	50/5"
		Bottom of exploration boring at 11 feet due to refusal. No groundwater encountered. Moved over 3 feet and attempted to re-drill. Met refusal at 7.5 feet.		
15				
20				
25				

Columns also include: S T, Graphic Symbol, Well Completion, Water Level, Other Tests. Blows/Foot scale: 10 20 30 40

Sampler Type (ST):
- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- Water Level ()
- Water Level at time of drilling (ATD)

Logged by: TJP
Approved by: CJK

AESBOR 180070.GPJ August 26, 2019

Figure 6-1

associated earth sciences incorporated

Exploration Boring

Project Number	Exploration Number	Sheet
180070E001	EB-3	1 of 1

Project Name	Issaquah HS #4 and ES #17	Ground Surface Elevation (ft)	525
Location	Issaquah, WA	Datum	NAVD 88
Driller/Equipment	Advance Drilling Technology / Track Rig	Date Start/Finish	6/25/19,6/25/19
Hammer Weight/Drop	140# / 30 inches	Hole Diameter (in)	7

Depth (ft)	Samples	DESCRIPTION	Blows/6"	Blows/Foot
		Forest Duff / Topsoil - 6 inches		
		Blakely Harbor Formation		
	S-1	Moist, mottled light brown, very silty, SAND, trace to some gravel (SM).	2 5 5	10
	S-2		8 8 11	19
5	S-3		6 9 13	22
10	S-4	Becomes very moist.	7 11 19	30
15	S-5	Trace fine gravel.	6 9 30	39
20	S-6	Becomes tan gray with heavy orange brown mottling. Contains coal fragments.	12 13 22	35
25	S-7	Becomes gravelly.	28 50/5"	50/5"
		Bottom of exploration boring at 26 feet No groundwater encountered.		

Sampler Type (ST):

- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- Water Level ()
- Water Level at time of drilling (ATD)

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Exploration Boring

Project Number	Exploration Number	Sheet
180070E001	EB-4	1 of 1

Project Name	Issaquah HS #4 and ES #17	Ground Surface Elevation (ft)	514
Location	Issaquah, WA	Datum	NAVD 88
Driller/Equipment	Advance Drilling Technology / Track Rig	Date Start/Finish	6/25/19,6/25/19
Hammer Weight/Drop	140# / 30 inches	Hole Diameter (in)	7

Depth (ft)	Samples	DESCRIPTION	Blows/6"	Blows/Foot
	S-1	**Fill** Very moist, reddish brown, very silty, gravelly, SAND; nonstratified (SM).	5 4 5	9
	S-2	**Blakely Harbor Formation** Very moist, reddish brown, gravelly, very silty, fine SAND; gravel fraction consists of angular sandstone fragments (SM).	2 2 3	5
5	S-3	Becomes tan and silty.	4 5 13	18
10	S-4	Contains angular gray gravel; poor recovery.	21 50 50/6"	50/6"
15	S-5		38 50/3"	50/3"
20	S-6	Becomes gray and more lithified.	50/5"	50/5"
		Bottom of exploration boring at 20 feet due to refusal. No groundwater encountered.		
25				

Column headings also include: S T, Graphic Symbol, Well Completion, Water Level, Other Tests; Blows/Foot scale 10 20 30 40.

Sampler Type (ST):

- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- Water Level ()
- Water Level at time of drilling (ATD)

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Approved by: CJK

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Exploration Boring

Project Number	Exploration Number	Sheet
180070E001	EB-5	1 of 1

Project Name	Issaquah HS #4 and ES #17	Ground Surface Elevation (ft)	520
Location	Issaquah, WA	Datum	NAVD 88
Driller/Equipment	Advance Drilling Technology / Track Rig	Date Start/Finish	6/25/19,6/25/19
Hammer Weight/Drop	140# / 30 inches	Hole Diameter (in)	7

Depth (ft)	ST	Samples	DESCRIPTION	Blows/6"	Blows/Foot
			Asphalt - 1.5 inches thick		
			Vashon Lodgement Till		
		S-1	Moist, brown, very gravelly, very silty, SAND; rounded gravel (SM).	18 19 50/6"	50/6"
			Blakely Harbor Formation		
		S-2	Moist, gray, silty, SAND; contains angular rock fragments (SM).	22 38 50/6"	50/6"
5		S-3	Orange brown mottling.	28 33 50/3"	50/3"
10		S-4	Becomes more heavily mottled.	18 50/4"	50/4"
		S-5		50/4"	50/4"
			Bottom of exploration boring at 14 feet due to refusal. No groundwater encountered.		
15					
20					
25					

Column headings also include: Graphic Symbol; Well Completion; Water Level; Other Tests. Blows/Foot scale: 10 20 30 40

Sampler Type (ST):

- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- Water Level ()
- Water Level at time of drilling (ATD)

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Approved by: CJK

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Exploration Boring

Project Number	Exploration Number	Sheet
180070E001	EB-6	1 of 1

Project Name	Issaquah HS #4 and ES #17	Ground Surface Elevation (ft)	520
Location	Issaquah, WA	Datum	NAVD 88
Driller/Equipment	Advance Drilling Technology / Track Rig	Date Start/Finish	6/26/19,6/26/19
Hammer Weight/Drop	140# / 30 inches	Hole Diameter (in)	7

Depth (ft)	Samples	DESCRIPTION	Blows/6"	Blows/Foot
		Asphalt - 2 inches		
		Vashon Lodgement Till		
	S-1	Moist, grayish tan, gravelly, very silty, SAND; nonstratified (SM).	8 10 15	25
	S-2	Some gravel.	12 21 27	48
5	S-3	Trace gravel; contains scattered thin lenses (<1/8 inches thick) of fine sand.	18 11 18	29
		Blakely Harbor Formation		
		Gravelly drilling at 9 feet.		
10	S-4	Moist, yellowish tan to gray, silty, SAND; contains angular rock fragments (SM).	50/6"	50/6"
	S-5		46 50/3"	50/3"
		Bottom of exploration boring at 12.25 feet due to refusal. No groundwater encountered.		
15				
20				
25				

Sampler Type (ST):

2" OD Split Spoon Sampler (SPT)
3" OD Split Spoon Sampler (D & M)
Grab Sample
No Recovery
Ring Sample
Shelby Tube Sample
M - Moisture
Water Level ()
Water Level at time of drilling (ATD)

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Exploration Boring

Project Number	Exploration Number	Sheet
180070E001	EB-7	1 of 1

Project Name	Issaquah HS #4 and ES #17	Ground Surface Elevation (ft)	520
Location	Issaquah, WA	Datum	NAVD 88
Driller/Equipment	Advance Drilling Technology / Track Rig	Date Start/Finish	6/26/19,6/26/19
Hammer Weight/Drop	140# / 30 inches	Hole Diameter (in)	7

Depth (ft)	ST	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot (10 20 30 40)	Other Tests
				Asphalt - 2.5 inches					
				Vashon Lodgement Till					
		S-1		Moist, grayish tan, gravelly, very silty, SAND; nonstratified (SM).			8 6 10	▲16	
		S-2					10 18 50/5"	▲50/5"	
5		S-3		Poor recovery, driving a rock.			25 50/5"	▲50/5"	
				Very difficullt drilling.					
		S-4		Becomes yellowish tan, very gravelly.			14 46 50/5"	▲50/5"	
10		S-5		No recovery.			50/1"	▲50/1"	
				Bottom of exploration boring at 10 feet due to refusal. No groundwater encountered.					
15									
20									
25									

Sampler Type (ST):

- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- Water Level ()
- Water Level at time of drilling (ATD)

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Exploration Boring

Project Number	Exploration Number	Sheet
180070E001	EB-8	1 of 1

Project Name	Issaquah HS #4 and ES #17	Ground Surface Elevation (ft)	520
Location	Issaquah, WA	Datum	NAVD 88
Driller/Equipment	Advance Drilling Technology / Track Rig	Date Start/Finish	6/26/19,6/26/19
Hammer Weight/Drop	140# / 30 inches	Hole Diameter (in)	7

Depth (ft)	Samples	DESCRIPTION	Blows/6"	Blows/Foot
		Fill		
	S-1	Moist, tan, gravelly, very silty, SAND (SM).	1 2 2	4
	S-2	Trace tile debris.	3 3 4	7
		Vashon Lodgement Till		
5	S-3	Moist, grayish tan, gravelly, very silty, SAND; nonstratified (SM).	5 10 14	24
10	S-4	Becomes very moist.	14 25 36	61
		Drilling action becomes smoother at 12 feet.		
		Drilling action becomes gravelly.		
15	S-5		18 36 36	72
20	S-6	Becomes mottled with increased moisture.	16 15 20	35
		Possession Drift		
		Very moist, blue gray, SILT; contains fine sand partings; massive; effervesces in hydrochloric acid (ML).		
25	S-7	Becomes laminated.	9 12 16	28
		Bottom of exploration boring at 26.5 feet No groundwater encountered.		

Column headers also include: ST, Graphic Symbol, Well Completion, Water Level, Other Tests. Blows/Foot scale: 10, 20, 30, 40.

Sampler Type (ST):

- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- Water Level ()
- Water Level at time of drilling (ATD)

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Exploration Boring

Project Number	Exploration Number	Sheet
180070E001	EB-9	1 of 1

Project Name	Issaquah HS #4 and ES #17	Ground Surface Elevation (ft)	500
Location	Issaquah, WA	Datum	NAVD 88
Driller/Equipment	Advance Drilling Technology / Track Rig	Date Start/Finish	6/26/19,6/26/19
Hammer Weight/Drop	140# / 30 inches	Hole Diameter (in)	7

Depth (ft)	Samples	DESCRIPTION	Blows/6"	Blows/Foot
		Asphalt - 1.5 inches		
		Fill		
	S-1	Moist, grayish tan and brown (mixed), gravelly, very silty, SAND; contains scattered organic debris (SM).	12 16 11	27
		Vashon Lodgement Till		
	S-2	Very moist, tan gray, very silty, gravelly, SAND; nonstratified (SM).	6 9 12	21
5	S-3	Becomes tan to grayish tan.	8 16 24	40
10	S-4	Becomes moist.	16 24 30	54
15	S-5	Becomes very moist.	48 50/1"	50/1"
20	S-6		33 50/5"	50/5"
25	S-7	Poor recovery.	50/4"	50/4"
		Bottom of exploration boring at 25.5 feet No groundwater encountered.		

Sampler Type (ST):

- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- Water Level ()
- Water Level at time of drilling (ATD)

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Exploration Boring

Project Number	Exploration Number	Sheet
180070E001	EB-10	1 of 1

Project Name: Issaquah HS #4 and ES #17
Location: Issaquah, WA
Driller/Equipment: Advance Drilling Technology / Track Rig
Hammer Weight/Drop: 140# / 30 inches

Ground Surface Elevation (ft): 465
Datum: NAVD 88
Date Start/Finish: 6/26/19,6/26/19
Hole Diameter (in): 7

Depth (ft)	Samples	DESCRIPTION	Blows/6"	Blows/Foot
		Blakely Harbor Formation		
	S-1	Very moist, brown to tan, very silty, gravelly, SAND (SM).	5 5 8	13
	S-2		9 15 18	33
5		Becomes moist, grayish tan, silty with angular gravel sized sedimentary rock fragments.		
	S-3	Becomes tan to yellowish tan.	11 15 22	37
10	S-4	Becomes mottled and fine grained (siltstone); angular rock fragments still present.	50/5"	50/5"
15	S-5		13 29 50/5"	50/5"
20	S-6	Poor recovery.	50/2"	50/2"
		Bottom of exploration boring at 20 feet due to refusal. No groundwater encountered.		
25				

Column headings: Depth (ft) | ST | Samples | Graphic Symbol | DESCRIPTION | Well Completion | Water Level | Blows/6" | Blows/Foot (10 20 30 40) | Other Tests

Sampler Type (ST):
- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- Water Level ()
- Water Level at time of drilling (ATD)

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Exploration Boring

Project Number	Exploration Number	Sheet
180070E001	EB-11	1 of 3

Project Name	Issaquah HS #4 and ES #17	Ground Surface Elevation (ft)	500
Location	Issaquah, WA	Datum	NAVD 88
Driller/Equipment	Advance Drilling Technology / Track Rig	Date Start/Finish	6/27/19,6/27/19
Hammer Weight/Drop	140# / 30 inches	Hole Diameter (in)	7

Depth (ft)	Samples	DESCRIPTION	Blows/6"	Blows/Foot
		Vashon Lodgement Till		
	S-1	Very moist, grayish tan, very silty, gravelly, SAND; nonstratified (SM).	6 9 9	18
	S-2	Becomes moist.	29 50/6"	50/6"
		Met with refusal at 4 feet; moved over 4 feet and resumed drilling.		
5	S-3		4 37 50/5"	50/5"
10	S-4	Becomes very moist.	50/3"	50/3"
15	S-5	Becomes very moist.	14 50/4"	50/4"
20	S-6		50/6"	50/6"
25	S-7	Becomes very moist, slightly less gravelly, and sightly more silty.	13 21 30	51
		Driller adding water (~1 to 2 gallons).		
		Olympia Nonglacial Sediments ?		
		Drilling action becomes smooth below ~28 feet.		

Sampler Type (ST):

- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- Water Level ()
- Water Level at time of drilling (ATD)

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Exploration Boring

Project Number	Exploration Number	Sheet
180070E001	EB-11	2 of 3

Project Name: Issaquah HS #4 and ES #17
Location: Issaquah, WA
Driller/Equipment: Advance Drilling Technology / Track Rig
Hammer Weight/Drop: 140# / 30 inches
Ground Surface Elevation (ft): 500
Datum: NAVD 88
Date Start/Finish: 6/27/19,6/27/19
Hole Diameter (in): 7

Depth (ft)	Samples	DESCRIPTION	Blows/6"	Blows/Foot
	S-8	Moist, tan gray, fine to medium SAND, some silt (SP-SM).	18 30 41	71
	S-9	Sand becomes tan, silty, and fine grained. Moist, tan, SILT; nonplastic; massive; driller adding water (ML).	27 39 50/6"	50/6"
35	S-10		11 37 50/5"	50/5"
	S-11	Trace gravel.	27 50/6"	50/6"
40	S-12	Contains a lens (~3 inches thick) of lightly mottled, fine sandy, silt at ~40.5 feet.	20 39 50	50/6"
45	S-13		12 20 33	53
		Pre-Fraser Till Gravelly drilling action at 48 feet.		
50	S-14	Moist, grayish tan, very silty, gravelly, SAND; nonstratified (SM).	20 32 48	80
55	S-15	Slight increase in moisture content. Becomes very moist and gray.	12 33 50/5"	50/5"

Sampler Type (ST):

- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- Water Level ()
- Water Level at time of drilling (ATD)

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Exploration Boring

Project Number	Exploration Number	Sheet
180070E001	EB-11	3 of 3

Project Name: Issaquah HS #4 and ES #17
Location: Issaquah, WA
Driller/Equipment: Advance Drilling Technology / Track Rig
Hammer Weight/Drop: 140# / 30 inches

Ground Surface Elevation (ft): 500
Datum: NAVD 88
Date Start/Finish: 6/27/19,6/27/19
Hole Diameter (in): 7

Depth (ft)	Samples	DESCRIPTION	Blows/6"	Blows/Foot
	S-16		13 33 50/6"	50/6"
		Driller adding water.		
65	S-17		16 22 27	49
		Pre-Fraser Silt Drilling action becomes smooth below 68 feet.		
70	S-18	Moist, mottled tan, SILT; nonplastic; contains thin sand lens (~1 inch thick) at 71 feet; non-reactive in hydrochloric acid (ML).	17 27 40	67
75	S-19	Moist, grayish tan, very silty, fine SAND; frequent thin lenses (~2 inches thick) of silt (SM).	16 27 46	73
80	S-20	**Blakely Harbor Formation** Gravelly drilling action at 80 feet. Moist, gray, very silty, gravelly, SAND; nonstratified (SM).	50/6"	50/6"
85	S-21	Becomes greenish gray, very gravelly, and contains pink rock fragments.	40 50/3"	50/3"
		Bottom of exploration boring at 85.75 feet No groundwater encountered.		

Sampler Type (ST):
- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- Water Level ()
- Water Level at time of drilling (ATD)

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Exploration Boring

Project Number	Exploration Number	Sheet
180070E001	EB-12	1 of 1

Project Name	Issaquah HS #4 and ES #17	Ground Surface Elevation (ft)	505
Location	Issaquah, WA	Datum	NAVD 88
Driller/Equipment	Advance Drilling Technology / Track Rig	Date Start/Finish	6/28/19,6/28/19
Hammer Weight/Drop	140# / 30 inches	Hole Diameter (in)	7

Depth (ft)	Samples	DESCRIPTION	Blows/6"	Blows/Foot
		Vashon Lodgement Till		
	S-1	Very moist, mottled tan, very silty, gravelly, SAND; nonstratified (SM).	5 9 9	18
		Vashon Ice Contact		
	S-2	Very moist, mottled tan, fine sandy, SILT, some gravel; nonplastic (ML).	4 5 6	11
5	S-3	Trace to some gravel.	4 6 10	16
10	S-4	No gravel. Becomes blue gray below 11 feet.	5 10 15	25
		Blakely Harbor Formation		
15	S-5	Gravelly drilling action below 14.5 feet. Moist, purplish gray, silty, fine SAND, trace organics (SM).	15 41 50/4"	50/4"
	S-6	Becomes purplish greenish gray and fine to medium grained with some pebble gravel.	50/5"	50/5"
		Bottom of exploration boring at 18 feet due to refusal. No groundwater encountered.		
20				
25				

Sampler Type (ST):

- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- Water Level ()
- Water Level at time of drilling (ATD)

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Approved by: CJK

AESBOR 180070.GPJ August 26, 2019

LOG OF EXPLORATION PIT NO. EP-1

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION** Elev: 505 ft
	Topsoil - 6 inches
	Weathered Vashon Lodgement Till
1	Loose, very moist, brown, very silty, gravelly, SAND; abundant roots (SM).
2	Becomes medium dense and tan below 2 feet.
3	
	Vashon Lodgement Till
4	Hard, very moist, grayish tan, fine sandy, SILT; oxidized fracture surfaces; nonstratified (ML).
5	
6	Trace to some gravel below 6 feet.
7	
8	
9	Bottom of exploration pit at depth 8.5 feet No seepage. No caving.
10	
11	
12	

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Issaquah HS #4 and ES #17
Issaquah, WA

Logged by: TJP

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Project No. 180070E001

12/12/18

LOG OF EXPLORATION PIT NO. EP-2

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

Depth (ft)	DESCRIPTION — Elev: 510 ft
	Topsoil - 6 inches
	Weathered Vashon Lodgement Till
1	Loose, wet, reddish brown, very silty, gravelly, SAND (SM).
2	Abundant roots to 2.5 feet.
	Becomes medium dense, very moist, and grayish tan below 2.5 feet.
3	
	Vashon Lodgement Till
4	Very dense, moist, grayish tan, very silty, gravelly, SAND; nonstratified (SM).
5	
6	
7	
8	
	Bottom of exploration pit at depth 8 feet No seepage. No caving.
9	
10	
11	
12	

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Issaquah HS #4 and ES #17
Issaquah, WA

Logged by: TJP

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Project No. 180070E001

12/12/18

LOG OF EXPLORATION PIT NO. EP-3

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

Depth (ft)	DESCRIPTION — Elev: 485 ft
	Topsoil - 8 inches
1	**Weathered Vashon Lodgement Till** Loose, very moist, brown to reddish brown, very silty, gravelly, SAND (SM).
2	
3	Abundant roots 0 to 2.5 feet. Becomes medium dense, increased moisture, and grayish tan with mottling below 2.5 feet.
4	**Vashon Lodgement Till** Dense, very moist, grayish tan, very silty, gravelly, SAND; scattered cobbles; mottled above 5 feet (sandy till); nonstratified (SM).
5	
6	
7	
8	Bottom of exploration pit at depth 8 feet No seepage. No caving.
9	
10	
11	
12	

Issaquah HS #4 and ES #17
Issaquah, WA

Logged by: TJP

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Project No. 180070E001

12/13/19

LOG OF EXPLORATION PIT NO. EP-4

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION** Elev: 480 ft
	Topsoil - 10 inches
1	**Blakely Harbor Formation** Loose, very moist, brown, very silty, SAND, some gravel; abundant roots (SM).
2	
3	Soft to medium stiff, very moist to wet, yellowish tan, SILT (ML).
4	
5	
6	Medium dense to dense, very moist, yellowish tan, very silty, fine SAND (SM) and hard, fine sandy, SILT (ML); stratified (sandstone/siltstone).
7	
8	
9	Bottom of exploration pit at depth 9 feet Moderately rapid seepage 2 to 4 feet. Moderate sloughing 2 to 4 feet.
10	
11	
12	

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Issaquah HS #4 and ES #17
Issaquah, WA

Logged by: TJP
Approved by: CJK

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Project No. 180070E001

12/12/18

LOG OF EXPLORATION PIT NO. EP-5

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION** Elev: 476 ft
	Topsoil - 6 inches
	Weathered Vashon Lodgement Till
1	Loose to medium dense, very moist, brown, very silty, gravelly, SAND; scattered cobbles; abundant roots (SM).
2	**Blakely Harbor Formation**
	Medium dense to dense, very moist, yellowish tan, very silty, SAND (SM).
3	
4	
5	
6	Becomes very dense below 6 feet.
7	Bottom of exploration pit at depth 7 feet No seepage. No caving.
8	
9	
10	
11	
12	

Issaquah HS #4 and ES #17
Issaquah, WA

Logged by: TJP

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Project No. 180070E001

12/13/18

LOG OF EXPLORATION PIT NO. EP-6

Depth (ft)

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

DESCRIPTION

Elev: 482 ft

Topsoil - 6 inches

Weathered Vashon Lodgement Till

1 — Loose, very moist, reddish brown, very silty, gravelly, SAND (SM).

Abundant roots 0 to 2 feet.

2 — Becomes medium dense and tan below 2 feet.

3 —

Vashon Lodgement Till

Dense, very moist, mottled grayish tan, very silty, gravelly, SAND; scattered cobbles and boulders; nonstratified (SM).

4 —

5 —

6 —

7 — Wet at 7 feet.

8 —

9 —

Bottom of exploration pit at depth 9 feet
Slow discontinuous seepage at 7 feet. No caving.

10 —

11 —

12

Issaquah HS #4 and ES #17
Issaquah, WA

Logged by: TJP

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Project No. 180070E001

12/13/18

KC-3 180070.GPJ August 23, 2019

LOG OF EXPLORATION PIT NO. EP-7

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

Depth (ft)	DESCRIPTION — Elev: 505 ft
0–1	**Fill** Loose, very moist, brown, very silty, gravelly, SAND (SM).
1–5	**Vashon Lodgement Till** Very dense, moist, tan gray, very silty, gravelly, SAND; nonstratified (SM). Very difficult digging.
5	Bottom of exploration pit at depth 5 feet No seepage. No caving.
6	
7	
8	
9	
10	
11	
12	

KC_E3 180070.GPJ August 23, 2019

Issaquah HS #4 and ES #17
Issaquah, WA

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Project No. 180070E001

12/10/18

PRJ19-00008 Attachment 054

LOG OF EXPLORATION PIT NO. EP-8

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION** Elev: 500 ft
	Fill
	Loose, moist, brown, very silty, gravelly, SAND (SM).
1	
2	
3	Abundant roots 0 to 4 feet
4	Becomes tan below 4 feet.
5	
6	
7	
8	**Weathered Vashon Lodgement Till**
	Medium dense, moist, reddish brown, very silty, gravelly, SAND (SM).
9	
10	Clay pipe encountered at 10 feet in north end of excavation.
	Vashon Lodgement Till
11	Very dense, moist, grayish tan, very silty, SAND, some gravel; nonstratified (SM).
	Bottom of exploration pit at depth 11 feet No seepage. No caving.
12	

KC_TP3 180070.GPJ August 23, 2019

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Issaquah, WA

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12/12/18

~~PRJ19-00008 Attachment 054~~

LOG OF EXPLORATION PIT NO. EP-9

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION** Elev: 510 ft
	Fill
	Loose, very moist, brown, very silty, SAND, some gravel; contains pockets of clean sand (SM).
1	**Vashon Lodgement Till**
	Very dense, moist, grayish tan, very silty, gravelly, SAND; scattered cobbles and boulders;
2	nonstratified (SM).
3	
4	
5	
6	
7	
	Bottom of exploration pit at depth 7 feet No seepage. No caving.
8	
9	
10	
11	
12	

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KC_13 180070.GPJ August 23, 2019

LOG OF EXPLORATION PIT NO. EP-10

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

Depth (ft)	DESCRIPTION — Elev: 512 ft
	Weathered Vashon Lodgement Till
	Loose, very moist, brown, very silty, gravelly, SAND; abundant roots; wet at base (SM).
1	**Vashon Lodgement Till**
	Very dense, very moist, grayish tan, very silty, gravelly, SAND; scattered boulders and cobbles;
2	nonstratified (SM).
	Becomes moist below ~2.5 feet.
3	
4	
5	
6	
	Bottom of exploration pit at depth 6 feet Refusal due to boulder. Slow seepage at 1 foot. No caving.
7	
8	
9	
10	
11	
12	

KCPB 180070.GPJ August 23, 2019

Issaquah HS #4 and ES #17
Issaquah, WA

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Project No. 180070E001

12/12/18

LOG OF EXPLORATION PIT NO. EP-11

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. DESCRIPTION Elev: 512 ft
	Fill
	Loose, very moist to wet, brown, very silty, gravelly, SAND; contains trace wood debris (SM).
1	
2	Clay pipe and wires encountered at ~2 and 3 feet.
3	
4	
5	
6	**Vashon Lodgement Till**
	Very dense, very moist, grayish tan, very silty, gravelly, SAND; nonstratified (SM).
7	Bottom of exploration pit at depth 7 feet Slow seepage at ~2 feet. Moderately severe caving at ~2 feet.
8	
9	
10	
11	
12	

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Project No. 180070E001

12/12/18

LOG OF EXPLORATION PIT NO. EP-12

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

Depth (ft)	DESCRIPTION — Elev: 492 ft
	Topsoil - 6 inches
	Weathered Vashon Lodgement Till
1	Dense, moist to very moist, reddish brown, very silty, gravelly, SAND; abundant roots (SM).
2	
3	
4	**Vashon Lodgement Till**
	Very dense, very moist, grayish tan, very silty, gravelly, SAND; nonstratified (SM).
5	Bottom of exploration pit at depth 5 feet No seepage. No caving. Broke water line during excavation; repaired.
6	
7	
8	
9	
10	
11	
12	

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Project No. 180070E001

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LOG OF EXPLORATION PIT NO. EP-13

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

Depth (ft)	DESCRIPTION Elev: 485 ft
	Topsoil - 6 inches
	Weathered Vashon Lodgement Till
1	Loose, very moist, reddish brown, very silty, gravelly, SAND (SM).
2	
	Abundant roots 0 to 2.5 feet. Becomes medium dense and grayish tan below 2.5 feet. Wet at base.
3	**Vashon Lodgement Till**
	Very dense, moist, grayish tan, very silty, gravelly, SAND; scattered cobbles; nonstratified (SM).
4	
5	
6	
7	
8	
	Bottom of exploration pit at depth 8 feet Slow seepage at 3 feet. No caving.
9	
10	
11	
12	

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Issaquah HS #4 and ES #17
Issaquah, WA

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Project No. 180070E001
12/13/18

LOG OF EXPLORATION PIT NO. EP-14

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

Depth (ft)	DESCRIPTION Elev: 476 ft
	Topsoil - 6 inches
	Weathered Vashon Lodgement Till
1	Loose, very moist, reddish brown, very silty, gravelly, SAND (SM).
2	
	Wet at 2.5 feet. Abundant roots 0 to 2.5 feet.
3	Becomes medium dense, very moist, and tan below 3 feet.
	Vashon Lodgement Till
4	Dense, very moist, tan, very silty, gravelly, SAND; scattered cobbles; nonstratified (SM).
	Lightly mottled 3.5 to 4.5 feet. Becomes very dense below 4.5 feet.
5	
6	
7	
	Bottom of exploration pit at depth 7 feet Slow seepage at 2.5 feet. No caving.
8	
9	
10	
11	
12	

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Issaquah, WA

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KC-3 180070.GPJ August 23, 2019

LOG OF EXPLORATION PIT NO. EP-15

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION** Elev: 477 ft
	Topsoil - 8 inches
	Weathered Vashon Lodgement Till
1	Loose, very moist, reddish brown, gravelly, very silty, SAND; scattered cobbles (SM).
2	
	Wet at 2.5 feet. Abundant roots 0 to 2.5 feet. Becomes medium dense and tan below 2.5 feet.
3	
	Vashon Lodgement Till
4	Dense, very moist, grayish tan, very silty, gravelly, SAND; scattered cobbles; nonstratified (SM). Mottled 3.5 to 5 feet.
5	
6	Becomes very dense below ~6 feet.
7	
8	
	Bottom of exploration pit at depth 8 feet Moderately rapid seepage at 2.5 feet. No caving.
9	
10	
11	
12	

KC-3 180070.GPJ August 23, 2019

Issaquah HS #4 and ES #17
Issaquah, WA

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Project No. 180070E001

12/13/18

LOG OF EXPLORATION PIT NO. EP-16

Depth (ft)

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

DESCRIPTION

Elev: 480 ft

Forest Duff

Fill

Very dense, moist, grayish brown, very silty, gravelly, SAND; scattered cobbles (SM).

1

Medium dense to dense, moist, grayish brown, very gravelly, fine to medium SAND, trace silt; scattered cobbles (SP).

2

Abundant wood debris below ~2.5 feet.

3

Pockets of silty, sand below 3 feet.

4

Vashon Lodgement Till

Dense, very moist, gray, very silty, gravelly, SAND; scattered cobbles; nonstratified (SM).

5

6

Becomes tan gray below 6 feet.

7

8

Bottom of exploration pit at depth 8 feet
No seepage. No caving.

9

10

11

12

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LOG OF EXPLORATION PIT NO. EP-17

Depth (ft)

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

DESCRIPTION

Elev: 489 ft

Depth (ft)	Description
	Topsoil - 6 inches
	Weathered Vashon Lodgement Till
1	Loose, very moist, reddish brown, very silty, gravelly, SAND (SM).
2	
	Abundant roots 0 to 3 feet.
3	Becomes medium dense and tan below 3 feet.
4	
5	**Vashon Lodgement Till**
	Dense, very moist, grayish tan, very silty, gravelly, SAND; scattered cobbles; nonstratified (SM).
6	
7	Becomes very dense below 7 feet.
8	Bottom of exploration pit at depth 8 feet No seepage. No caving.
9	
10	
11	
12	

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LOG OF EXPLORATION PIT NO. EP-18

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

Depth (ft)	DESCRIPTION Elev: 501 ft
	Topsoil - 6 inches
	Fill
1	Medium dense, moist to very moist, grayish tan, fine to medium SAND, some silt; scattered wood debris; wet at 2 feet (SP-SM).
2	**Vashon Lodgement Till**
	Very dense, very moist, grayish tan, very silty, gravelly, SAND; nonstratified (SM).
3	
4	
5	Bottom of exploration pit at depth 4.5 feet Refusal due to a large boulder. Slow seepage at 2 feet. No caving.
6	
7	
8	
9	
10	
11	
12	

Issaquah HS #4 and ES #17
Issaquah, WA

KC_13 180070.GPJ August 23, 2019

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Project No. 180070E001

12/12/18

LOG OF EXPLORATION PIT NO. EP-19

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

Depth (ft)	DESCRIPTION Elev: 502 ft
	Sod / Topsoil - 6 inches
	Weathered Vashon Lodgement Till
1	Medium dense, very moist, brown, gravelly, silty, SAND; wet at 1.5 feet (SM).
	Vashon Lodgement Till
2	Very dense, wet, grayish tan, very silty, gravelly, SAND; scattered cobbles; nonstratified (SM).
3	
4	
5	
6	
7	Bottom of exploration pit at depth 7 feet Slow seepage at 1.5 feet. No caving.
8	
9	
10	
11	
12	

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KC-03 180070.GPJ August 23, 2019

LOG OF EXPLORATION PIT NO. EP-20

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

Depth (ft)	DESCRIPTION — Elev: 499 ft
	Sod / Topsoil - 6 inches
	Vashon Lodgement Till
1	Very dense, very moist, grayish tan, very silty, gravelly, SAND; scattered cobbles; nonstratified (SM). Becomes moist below ~1 foot.
2	
3	
4	Becomes tan gray below ~4 feet.
5	
6	Very difficult digging.
	Bottom of exploration pit at depth 6 feet No seepage. No caving.
7	
8	
9	
10	
11	
12	

Issaquah HS #4 and ES #17
Issaquah, WA

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Project No. 180070E001

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LOG OF EXPLORATION PIT NO. EP-21

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION** Elev: 490 ft
	Topsoil - 6 inches
	Weathered Vashon Lodgement Till
1	Loose, moist, reddish brown to brown, very silty, gravelly, SAND (SM).
2	Abundant roots 0 to 2 feet. Becomes medium dense, very moist, and tan below 2 feet.
3	Wet at 3.5 feet.
	Vashon Lodgement Till
4	Very dense, moist, grayish tan, very silty, gravelly, SAND; nonstratified (SM).
	Mottled 3.5 to 4.5 feet.
5	
6	
7	
8	
9	
10	Bottom of exploration pit at depth 9.5 feet Slow seepage at 3.5 feet. No caving.
11	
12	

KC-3 180070.GPJ August 23, 2019

Issaquah HS #4 and ES #17
Issaquah, WA

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Project No. 180070E001

12/10/18

LOG OF EXPLORATION PIT NO. EP-22

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

Depth (ft)	DESCRIPTION Elev: 478 ft
	Topsoil - 8 inches
	Weathered Vashon Lodgement Till
1	Loose, moist, reddish brown, very silty, gravelly, SAND (SM).
	Abundant roots 0 to 2 feet.
2	Becomes medium dense, very moist, and tan below 2 feet.
3	
4	**Vashon Lodgement Till**
	Dense, moist, tan, very silty, gravelly, SAND; nonstratified (SM).
5	Mottled 4 to 5 feet.
	Very dense and grayish tan below 5 feet.
6	
7	
8	
9	Bottom of exploration pit at depth 8.5 feet No seepage. No caving.
10	
11	
12	

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Issaquah HS #4 and ES #17
Issaquah, WA

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Project No. 180070E001

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LOG OF EXPLORATION PIT NO. EP-23

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

Depth (ft)	DESCRIPTION — Elev: 460 ft
	Topsoil - 6 inches
	Weathered Vashon Lodgement Till
1	Loose, moist, reddish brown, very silty, gravelly, SAND (SM).
2	Becomes medium dense and tan below 2 feet. Abundant roots 0 to 2 feet.
3	**Vashon Lodgement Till**
	Very dense, moist, grayish tan, very silty, gravelly, SAND; nonstratified (SM).
4	
5	
6	
7	
8	Bottom of exploration pit at depth 8 feet No seepage. No caving.
9	
10	
11	
12	

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Project No. 180070E001

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KC-23 180070.GPJ August 23, 2019

LOG OF EXPLORATION PIT NO. EP-24

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION** Elev: 445 ft
	Topsoil - 6 inches
	Weathered Vashon Lodgement Till
1	Loose, moist, reddish brown, very silty, gravelly, SAND (SM).
2	
	Becomes medium dense and tan below 2.5 feet.
3	
	Vashon Lodgement Till
4	Very dense, moist, grayish tan, very silty, gravelly, SAND; scattered cobbles and boulders; nonstratified (SM). Mottled 3.5 to 4.5 feet.
5	
6	
7	
8	
9	
	Bottom of exploration pit at depth 9 feet No seepage. No caving.
10	
11	
12	

KC_S3 180070.GPJ August 23, 2019

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Issaquah, WA

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LOG OF EXPLORATION PIT NO. EP-25

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

Depth (ft)	DESCRIPTION (Elev: 425 ft)
	Topsoil - 6 inches
	Weathered Vashon Lodgement Till
1	Loose, moist, reddish brown, very silty, gravelly, SAND (SM).
2	
3	Abundant roots 0 to 3 feet. Becomes medium dense and tan below 3 feet.
4	
	Vashon Lodgement Till
5	Very dense, moist, grayish tan, very silty, gravelly, SAND; scattered boulders and cobbles; nonstratified (SM). Mottled 4.5 to 6 feet.
6	
7	
8	
9	
10	Bottom of exploration pit at depth 10 feet No seepage. No caving.
11	
12	

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LOG OF EXPLORATION PIT NO. EP-26

Depth (ft)

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

DESCRIPTION

Elev: 420 ft

Depth (ft)	Description
	Topsoil - 6 inches
	Weathered Vashon Lodgement Till
1	Loose, moist, reddish brown, very silty, SAND, some gravel (SM).
2	Abundant roots 0 to 2 feet. Becomes medium dense, very moist, and tan below 2 feet.
3	**Vashon Lodgement Till**
	Very dense, moist, grayish tan, very silty, gravelly, SAND; scattered cobbles; nonstratified (SM).
4	Mottled 3 to 4 feet.
5	
6	
7	
8	Bottom of exploration pit at depth 8 feet No seepage. No caving.
9	
10	
11	
12	

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LOG OF EXPLORATION PIT NO. EP-27

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION** Elev: 425 ft
	Topsoil - 6 inches
	Weathered Vashon Lodgement Till
1	Loose, moist, reddish brown, very silty, gravelly, SAND; scattered cobbles (SM).
	Medium dense, very moist, and tan below 1.5 feet. Abundant roots 0 to 1.5 feet.
2	
	Vashon Lodgement Till
3	Very dense, moist, grayish tan, very silty, gravelly, SAND; nonstratified (SM).
4	
5	
6	
7	
8	
	Bottom of exploration pit at depth 8 feet No seepage. No caving.
9	
10	
11	
12	

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LOG OF EXPLORATION PIT NO. EP-28

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

Depth (ft)	DESCRIPTION — Elev: 460 ft
	Topsoil - 6 inches
	Weathered Vashon Lodgement Till
1	Loose, moist, reddish brown, very silty, gravelly, SAND (SM).
2	
	Abundant roots 0 to 2.5 feet. Becomes medium dense, very moist, and tan below 2.5 feet.
3	
4	**Vashon Lodgement Till**
	Very dense, moist, tan, very silty, gravelly, SAND; scattered cobbles (SM).
5	
6	
7	
8	
	Bottom of exploration pit at depth 8 feet No seepage. No caving.
9	
10	
11	
12	

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LOG OF EXPLORATION PIT NO. EP-29

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

Depth (ft)	DESCRIPTION — Elev: 460 ft
	Topsoil - 6 inches
	Weathered Vashon Lodgement Till
1	Loose to medium dense, moist, reddish brown, very silty, gravelly, SAND; abundant roots (SM).
2	
3	
	Vashon Lodgement Till
4	Mottled 3.5 to 4.5 feet. Dense to very dense, moist, grayish tan, very silty, gravelly, SAND; scattered cobbles; nonstratified (SM).
5	
6	Grades to tan gray below ~6 feet.
7	
8	
9	
	Bottom of exploration pit at depth 9 feet No seepage. No caving.
10	
11	
12	

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12/10/18

LOG OF EXPLORATION PIT NO. EP-30

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION** Elev: 485 ft
	Topsoil - 8 inches
1	**Weathered Vashon Lodgement Till** Loose, moist, brown, very silty, gravelly, SAND (SM). Abundant roots 0 to 1.5 feet.
2	
3	Becomes medium dense, very moist, and tan below 2.5 feet.
4	
5	
6	**Vashon Lodgement Till** Dense, moist, light yellowish tan, very silty, gravelly, SAND; scattered cobbles; nonstratified (SM).
7	
8	Bottom of exploration pit at depth 8 feet No seepage. No caving. Note: The color and density of the Till at this location suggests that it contains a significant percentage of reworked material from the underlying bedrock.
9	
10	
11	
12	

KC3 180070.GPJ August 23, 2019

Issaquah HS #4 and ES #17
Issaquah, WA

associated earth sciences incorporated

Logged by: TJP

Approved by: CJK

Project No. 180070E001

12/13/18

LOG OF EXPLORATION PIT NO. EP-31

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

Depth (ft)	DESCRIPTION — Elev: 490 ft
	Topsoil - 8 inches
	Weathered Vashon Lodgement Till
1	Loose to medium dense, very moist, reddish brown, very silty, gravelly, SAND (SM).
2	
	Abundant roots 0 to 3 feet.
3	Wet at 3 feet. Becomes medium dense and grayish tan below 3 feet.
	Vashon Lodgement Till
4	Dense, very moist, grayish tan, very silty, gravelly, SAND; scattered cobbles; nonstratified (SM).
	Mottled 3.5 to 4.5 feet. Becomes very dense below 4.5 feet.
5	
6	
7	
8	
	Bottom of exploration pit at depth 8 feet Slow seepage at 3 feet. Minor sloughing at 3 feet.
9	
10	
11	
12	

Issaquah HS #4 and ES #17
Issaquah, WA

Logged by: TJP

Approved by: CJK

associated earth sciences incorporated

Project No. 180070E001

12/13/18

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TEST PIT NUMBER TP-1

PAGE 1 OF 1

CLIENT Plateau Campus, LLC
PROJECT NAME Plateau Campus Property
PROJECT NUMBER 3333
PROJECT LOCATION Issaquah, Washington
DATE STARTED 5/5/14 COMPLETED 5/5/14
GROUND ELEVATION ______ TEST PIT SIZE ______
EXCAVATION CONTRACTOR NW Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD ______
AT TIME OF EXCAVATION ---
LOGGED BY SHA CHECKED BY SSR
AT END OF EXCAVATION ---
NOTES Depth of Topsoil & Sod 10": bare soil
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL		TOPSOIL
				1.0	Brown silty SAND with gravel, loose to medium dense, moist (Weathered Till)
		MC = 16.90% Fines = 24.00%			-mottled with light iron oxide staining, becomes dense
5		MC = 12.50%	SM		-becomes very dense and unweathered, perched seepage
				7.0	Test pit terminated at 7.0 feet below existing grade. Groundwater seepage encountered at 4.0 feet during excavation.
					Bottom of test pit at 7.0 feet.

GENERAL BH / TP / WELL 3333.GPJ GINT US.GDT 6/5/14

Figure 6-1

PRJ19-00008 Attachment 054

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TEST PIT NUMBER TP-3

CLIENT Plateau Campus, LLC
PROJECT NAME Plateau Campus Property
PROJECT NUMBER 3333
PROJECT LOCATION Issaquah, Washington
DATE STARTED 5/5/14 COMPLETED 5/5/14
GROUND ELEVATION TEST PIT SIZE
EXCAVATION CONTRACTOR NW Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD
AT TIME OF EXCAVATION —
LOGGED BY SHA CHECKED BY SSR
AT END OF EXCAVATION —
NOTES Depth of Topsoil & Sod 12": Ivy
AFTER EXCAVATION —

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL		TOPSOIL
1.0		MC = 15.70% Fines = 29.10% MC = 8.00%	SM		Brown silty SAND with gravel, loose to medium dense, moist (Weathered Till) -heavy perched seepage -becomes very dense and unweathered
5 / 5.0					Test pit terminated at 5.0 feet below existing grade. Groundwater seepage encountered at 1.5 feet during excavation. Bottom of test pit at 5.0 feet.

GENERAL BH / TP / WELL 3333.GPJ GINT US.GDT 6/5/14

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TEST PIT NUMBER TP-4

PAGE 1 OF 1

CLIENT Plateau Campus, LLC

PROJECT NAME Plateau Campus Property

PROJECT NUMBER 3333

PROJECT LOCATION Issaquah, Washington

DATE STARTED 5/5/14 COMPLETED 5/5/14

GROUND ELEVATION TEST PIT SIZE

EXCAVATION CONTRACTOR NW Excavating

GROUND WATER LEVELS:

EXCAVATION METHOD

AT TIME OF EXCAVATION ---

LOGGED BY SHA CHECKED BY SSR

AT END OF EXCAVATION ---

NOTES Depth of Topsoil & Sod 18": ivy

AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL		TOPSOIL
1.5		MC = 11.80%	SM		Brown silty SAND with gravel, loose and medium dense, moist (Weathered Till)
		MC = 12.00%			
					-becomes very dense and unweathered
5					
		MC = 12.10%			
8.0					Test pit terminated at 8.0 feet below existing grade. Groundwater seepage encountered at 3.5 feet during excavation.
					Bottom of test pit at 8.0 feet.

GENERAL BH / TP / WELL 3333.GPJ GINT US.GDT 6/5/14

Figure 6-1

PRJ19-00008 Attachment 054

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TEST PIT NUMBER TP-5

CLIENT Plateau Campus, LLC	PROJECT NAME Plateau Campus Property
PROJECT NUMBER 3333	PROJECT LOCATION Issaquah, Washington
DATE STARTED 5/5/14 COMPLETED 5/5/14	GROUND ELEVATION ____ TEST PIT SIZE ____
EXCAVATION CONTRACTOR NW Excavating	GROUND WATER LEVELS:
EXCAVATION METHOD	AT TIME OF EXCAVATION ---
LOGGED BY SHA CHECKED BY SSR	AT END OF EXCAVATION ---
NOTES Depth of Topsoil & Sod 6": bare soil	AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG		MATERIAL DESCRIPTION
0			TPSL		0.5	TOPSOIL
						Brown silty SAND with gravel, medium dense, moist (Fill)
		MC = 14.30%				
5			SM			-becomes medium dense to dense
		MC = 16.80%				-native, unweathered till contact
10					10.0	Test pit terminated at 10.0 feet below existing grade. No groundwater encountered during excavation. Bottom of test pit at 10.0 feet.

GENERAL BH / TP / WELL 3333.GPJ GINT US.GDT 6/5/14

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TEST PIT NUMBER TP-6

PAGE 1 OF 1

CLIENT Plateau Campus, LLC
PROJECT NAME Plateau Campus Property
PROJECT NUMBER 3333
PROJECT LOCATION Issaquah, Washington
DATE STARTED 5/5/14 COMPLETED 5/5/14
GROUND ELEVATION TEST PIT SIZE
EXCAVATION CONTRACTOR NW Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD
AT TIME OF EXCAVATION —
LOGGED BY SHA CHECKED BY SSR
AT END OF EXCAVATION —
NOTES Depth of Topsoil & Sod 6": ferns
AFTER EXCAVATION —

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0		TPSL	0.5	TOPSOIL
		SM		Brown silty SAND with gravel, medium dense, moist (Weathered Till)
				-becomes very dense and unweathered
			4.0	Test pit terminated at 4.0 feet below existing grade. No groundwater encountered during excavation. Bottom of test pit at 4.0 feet.

GENERAL BH / TP / WELL 3333.GPJ GINT US.GDT 6/5/14

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TEST PIT NUMBER TP-7

PAGE 1 OF 1

CLIENT Plateau Campus, LLC

PROJECT NAME Plateau Campus Property

PROJECT NUMBER 3333

PROJECT LOCATION Issaquah, Washington

DATE STARTED 5/5/14 COMPLETED 5/5/14

GROUND ELEVATION ______ TEST PIT SIZE ______

EXCAVATION CONTRACTOR NW Excavating

GROUND WATER LEVELS:

EXCAVATION METHOD ______

AT TIME OF EXCAVATION ---

LOGGED BY SHA CHECKED BY SSR

AT END OF EXCAVATION ---

NOTES Depth of Topsoil & Sod 12": ferns

AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL		TOPSOIL
1.0		MC = 15.80%	SM		Brown silty SAND with gravel, medium dense, moist (Weathered Till) -cobbles -becomes very dense and unweathered -cobbles down to terminus of test pit
4.0		MC = 10.40% Fines = 11.30% MC = 21.60%	GP-GM		Brown poorly graded GRAVEL with silt and sand, dense, moist
13.0					Test pit terminated at 13.0 feet below existing grade. No groundwater encountered during excavation. Bottom of test pit at 13.0 feet.

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TEST PIT NUMBER TP-9

PAGE 1 OF 1

CLIENT Plateau Campus, LLC
PROJECT NAME Plateau Campus Property
PROJECT NUMBER 3333
PROJECT LOCATION Issaquah, Washington
DATE STARTED 5/5/14 COMPLETED 5/5/14
GROUND ELEVATION TEST PIT SIZE
EXCAVATION CONTRACTOR NW Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD
AT TIME OF EXCAVATION ---
LOGGED BY SHA CHECKED BY SSR
AT END OF EXCAVATION ---
NOTES Depth of Topsoil & Sod 12": duff
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL		TOPSOIL
1.0		MC = 23.20%	SM		Brown silty SAND with gravel, loose to medium dense, moist (Weathered Till) -fractured -cobbles, mottled texture
3.0 (5)		MC = 17.20%	GP-GM		Brown poorly graded GRAVEL with silt and sand, dense, moist
9.0					Test pit terminated at 9.0 feet below existing grade. No groundwater encountered during excavation. Bottom of test pit at 9.0 feet.

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TEST PIT NUMBER TP-8

PAGE 1 OF 1

CLIENT Plateau Campus, LLC
PROJECT NAME Plateau Campus Property
PROJECT NUMBER 3333
PROJECT LOCATION Issaquah, Washington
DATE STARTED 5/5/14 COMPLETED 5/5/14
GROUND ELEVATION TEST PIT SIZE
EXCAVATION CONTRACTOR NW Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD
AT TIME OF EXCAVATION ---
LOGGED BY SHA CHECKED BY SSR
AT END OF EXCAVATION ---
NOTES Depth of Topsoil & Sod 10": forest duff
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL	1.0	TOPSOIL
			SM		Brown silty SAND with gravel, loose to medium dense, moist (Weathered Till)
					-becomes very dense and unweathered
					-cobbles
5					
		MC = 19.70%		8.0	
					Test pit terminated at 8.0 feet below existing grade. No groundwater encountered during excavation.
					Bottom of test pit at 8.0 feet.

GENERAL BH / TP / WELL 3333.GPJ GINT US.GDT 6/5/14

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TEST PIT NUMBER TP-10

PAGE 1 OF 1

CLIENT Plateau Campus, LLC
PROJECT NAME Plateau Campus Property
PROJECT NUMBER 3333
PROJECT LOCATION Issaquah, Washington
DATE STARTED 5/5/14 COMPLETED 5/5/14
GROUND ELEVATION TEST PIT SIZE
EXCAVATION CONTRACTOR NW Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD
AT TIME OF EXCAVATION —
LOGGED BY SHA CHECKED BY SSR
AT END OF EXCAVATION —
NOTES Depth of Topsoil & Sod 10": blackberry bushes
AFTER EXCAVATION —

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0		TPSL	1.0	TOPSOIL
		SM	3.0	Brown silty SAND with gravel, medium dense, moist -cobbles and weathered fractured bedrock
5		GP-GM	5.0	Brown poorly graded GRAVEL with silt and sand, dense, moist
				Test pit terminated at 5.0 feet below existing grade. No groundwater encountered during excavation. Bottom of test pit at 5.0 feet.

GENERAL BH / TP / WELL 3333.GPJ GINT US.GDT 6/5/14

LOG OF TEST PIT NO. TP-1

FIGURE A-2

PROJECT NAME: Madison Pointe PROJ. NO: T-7252 LOGGED BY: CSD

LOCATION: Issaquah, Washington SURFACE CONDS: Heavy Understory APPROX. ELEV: 466 Feet

DATE LOGGED: July 8, 2015 DEPTH TO GROUNDWATER: N/A DEPTH TO CAVING: N/A

DEPTH (FT.)	SAMPLE NO.	DESCRIPTION	CONSISTENCY/ RELATIVE DENSITY	W (%)	POCKET PEN. (TSF)	REMARKS
0–1.5		Brown silty SAND, fine grained, dry, heavy organic inclusions. (SM) (Topsoil)	Loose			
1.5–4.5	1	Brown silty SAND with gravel, fine to medium grained, dry, roots. (SM)	Medium Dense	7.1		
4.5–10	2	Gray silty SAND with gravel to SAND with silt and gravel, fine to medium grained, dry to moist, cemented. (SM/SP-SM)	Very Dense	9.5		
10		Test pit terminated at approximately 10 feet. No groundwater seepage observed.				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. TP-2

FIGURE A-3

PROJECT NAME: Madison Pointe **PROJ. NO:** T-7252 **LOGGED BY:** CSD

LOCATION: Issaquah, Washington **SURFACE CONDS:** Heavy Understory **APPROX. ELEV:** 464 Feet

DATE LOGGED: July 8, 2015 **DEPTH TO GROUNDWATER:** N/A **DEPTH TO CAVING:** N/A

DEPTH (FT.)	SAMPLE NO.	DESCRIPTION	CONSISTENCY/ RELATIVE DENSITY	W (%)	POCKET PEN. (TSF)	REMARKS
0–1		Brown silty SAND, fine grained, dry, heavy organic inclusions. (SM) (Topsoil)	Loose			
1–3	1	Brown silty SAND with gravel, fine to medium grained, dry, roots. (SM)	Medium Dense	9.2		
3–5	2	Gray silty SAND with gravel, fine to medium grained, dry, cemented. (SM)	Dense	6.5		
5–10	3	Gray silty SAND with gravel to SAND with silt and gravel, fine to medium grained, moist, cemented. (SM/SP-SM)	Very Dense	8.1		
10–15		Test pit terminated at approximately 10 feet. No groundwater seepage observed.				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as indicative of other locations at the site.

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PRJ19-00008 Attachment 054

LOG OF TEST PIT NO. TP-3

FIGURE A-4

PROJECT NAME: Madison Pointe **PROJ. NO:** T-7252 **LOGGED BY:** CSD

LOCATION: Issaquah, Washington **SURFACE CONDS:** Moderate Understory **APPROX. ELEV:** 438 Feet

DATE LOGGED: July 8, 2015 **DEPTH TO GROUNDWATER:** N/A **DEPTH TO CAVING:** 0 to 3 Feet

DEPTH (FT.)	SAMPLE NO.	DESCRIPTION	CONSISTENCY/ RELATIVE DENSITY	W (%)	POCKET PEN. (TSF)	REMARKS
0		(6 inches ORGANICS)				
1	1	Brown silty SAND with gravel to SAND with silt and gravel, fine to medium grained, dry, roots. (SM/SP-SM)	Medium Dense	5.7		
3–5	2	Gray silty SAND with gravel to SAND with silt and gravel, fine to medium grained, dry to moist, cemented, occasional cobble. (SM/SP-SM)	Very Dense	4.9		
9		Test pit terminated at approximately 9 feet. No groundwater seepage observed. Minor caving observed in the upper 3 feet.				
15						

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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PRJ19-00008 Attachment 054

LOG OF TEST PIT NO. TP-4

FIGURE A-5

PROJECT NAME: Madison Pointe **PROJ. NO:** T-7252 **LOGGED BY:** CSD

LOCATION: Issaquah, Washington **SURFACE CONDS:** Minimal Understory **APPROX. ELEV:** 480 Feet

DATE LOGGED: July 8, 2015 **DEPTH TO GROUNDWATER:** N/A **DEPTH TO CAVING:** N/A

DEPTH (FT.)	SAMPLE NO.	DESCRIPTION	CONSISTENCY/ RELATIVE DENSITY	W (%)	POCKET PEN. (TSF)	REMARKS
0–1		Brown silty SAND, fine grained, dry, heavy organic inclusions. (SM) (Topsoil)	Loose			
1–4	1 (at 2)	Gray silty SAND with gravel, fine to medium grained, dry, some roots. (SM)	Dense	9.7		
4–10	2 (at 5); 3 (at 9)	Gray SILTSTONE, moist.	Very Dense	23.7; 25.1		
10		Test pit terminated at approximately 10 feet. No groundwater seepage observed.				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. TP-5

FIGURE A-6

PROJECT NAME: Madison Pointe PROJ. NO: T-7252 LOGGED BY: CSD

LOCATION: Issaquah, Washington SURFACE CONDS: Moderate Understory APPROX. ELEV: 490 Feet

DATE LOGGED: July 8, 2015 DEPTH TO GROUNDWATER: N/A DEPTH TO CAVING: N/A

DEPTH (FT.)	SAMPLE NO.	DESCRIPTION	CONSISTENCY/ RELATIVE DENSITY	W (%)	POCKET PEN. (TSF)	REMARKS
0–1		Brown silty SAND, fine grained, dry, heavy organic inclusions. (SM) (Topsoil)	Loose			
1–4	1 (at 2)	Brown silty SAND with gravel, fine to medium grained, dry, large roots. (SM)	Medium Dense	9.0		
4–9	2 (at 6)	Gray-brown silty SAND mixed with pieces of weathered SANDSTONE, fine to medium grained, dry, cobbles. (SM) *Sandstone pieces increase with depth, by 9 feet became difficult to excavate with 125 machine	Very Dense	11.6		
9–15		Test pit terminated at approximately 9 feet. No groundwater seepage observed.				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. TP-6

FIGURE A-7

PROJECT NAME: Madison Pointe **PROJ. NO:** T-7252 **LOGGED BY:** CSD

LOCATION: Issaquah, Washington **SURFACE CONDS:** Brush/Weeds **APPROX. ELEV:** 520 Feet

DATE LOGGED: July 8, 2015 **DEPTH TO GROUNDWATER:** N/A **DEPTH TO CAVING:** N/A

DEPTH (FT.)	SAMPLE NO.	DESCRIPTION	CONSISTENCY/ RELATIVE DENSITY	W (%)	POCKET PEN. (TSF)	REMARKS
	1	(less than 1" ORGANICS) FILL: gray sandy silt, fine grained, dry, roots, minor construction debris, large piece of concrete.	Medium Dense	11.0		
1						
2		Black silty SAND, fine to medium grained, dry, roots, heavy organic inclusions. (SM) (Topsoil)	Medium Dense			
3						
4	2		Dense	56.0		
5						
6		Red-brown SILTSTONE, very weathered, some cobbles, occasional boulders.				
7						
8						
9		@-9' material becomes less weathered, larger pieces	Very Dense			
10	3			46.6		
		Test pit terminated at approximately 10 feet. No groundwater seepage observed.				
11						
12						
13						
14						
15						

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. TP-7

FIGURE A-8

PROJECT NAME: Madison Pointe **PROJ. NO:** T-7252 **LOGGED BY:** CSD

LOCATION: Issaquah, Washington **SURFACE CONDS:** Heavy Understory **APPROX. ELEV:** 516 Feet

DATE LOGGED: July 8, 2015 **DEPTH TO GROUNDWATER:** N/A **DEPTH TO CAVING:** N/A

DEPTH (FT.)	SAMPLE NO.	DESCRIPTION	CONSISTENCY/ RELATIVE DENSITY	W (%)	POCKET PEN. (TSF)	REMARKS
0–2		Brown silty SAND, fine grained, dry, heavy organic inclusions. (SM) (Topsoil)	Loose			
2–3.5	1	Brown silty SAND with gravel, fine to medium grained, dry, roots. (SM)	Medium Dense	8.0		
3.5–7	2	Gray silty SAND with gravel to SAND with silt and gravel, fine to medium grained, dry, cemented. (SM/SP-SM)	Dense	5.9		
7		Test pit terminated at approximately 7 feet. No groundwater seepage observed.				

Depth scale: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. TP-8

FIGURE A-9

PROJECT NAME: Madison Pointe **PROJ. NO:** T-7252 **LOGGED BY:** CSD

LOCATION: Issaquah, Washington **SURFACE CONDS:** Moderate Understory **APPROX. ELEV:** 482 Feet

DATE LOGGED: July 8, 2015 **DEPTH TO GROUNDWATER:** N/A **DEPTH TO CAVING:** N/A

DEPTH (FT.)	SAMPLE NO.	DESCRIPTION	CONSISTENCY/ RELATIVE DENSITY	W (%)	POCKET PEN. (TSF)	REMARKS
0–1.5		Brown silty SAND, fine grained, dry, heavy organic inclusions. (SM) (Topsoil)	Loose			
1.5–4.5	1 (at ~2–2.5)	Brown SAND with silt and gravel, fine to medium grained, dry, roots. (SP-SM)	Medium Dense	5.3		
4.5–9	2 (at ~7–7.5)	Gray silty SAND with gravel, fine to medium grained, dry to moist, cemented, some cobbles/boulders. (SM/SP-SM)	Dense Very Dense	12.7		
9–10	3 (at ~9.5)	Red-brown SANDSTONE, moist, weathered, difficult to excavate.	Very Dense	10.7		
10		Test pit terminated at approximately 10 feet. No groundwater seepage observed.				

Depth scale: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. TP-9

FIGURE A-10

PROJECT NAME: Madison Pointe **PROJ. NO:** T-7252 **LOGGED BY:** CSD

LOCATION: Issaquah, Washington **SURFACE CONDS:** Moderate Understory **APPROX. ELEV:** 482 Feet

DATE LOGGED: July 8, 2015 **DEPTH TO GROUNDWATER:** N/A **DEPTH TO CAVING:** N/A

DEPTH (FT.)	SAMPLE NO.	DESCRIPTION	CONSISTENCY/ RELATIVE DENSITY	W (%)	POCKET PEN. (TSF)	REMARKS
0–1.5		Brown silty SAND, fine grained, dry, heavy organic inclusions. (SM) (Topsoil)	Loose			
1.5–3	1	Brown silty SAND with gravel, fine to medium grained, dry, roots. (SM)	Medium Dense	7.2		
3–11	2	Gray silty SAND with gravel to SAND with silt and gravel, fine to medium grained, dry to moist, some cementation, occasional cobble/boulder. (SM/SP-SM)	Very Dense	8.0		
		*Soil becomes less cemented with depth.				
9	3	*At 9 feet soil becomes wet.		11.6		
11		Test pit terminated at approximately 11 feet. No groundwater seepage observed.				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. TP-10

FIGURE A-11

PROJECT NAME: Madison Pointe **PROJ. NO:** T-7252 **LOGGED BY:** CSD

LOCATION: Issaquah, Washington **SURFACE CONDS:** Moderate Understory **APPROX. ELEV:** 503 Feet

DATE LOGGED: July 8, 2015 **DEPTH TO GROUNDWATER:** N/A **DEPTH TO CAVING:** N/A

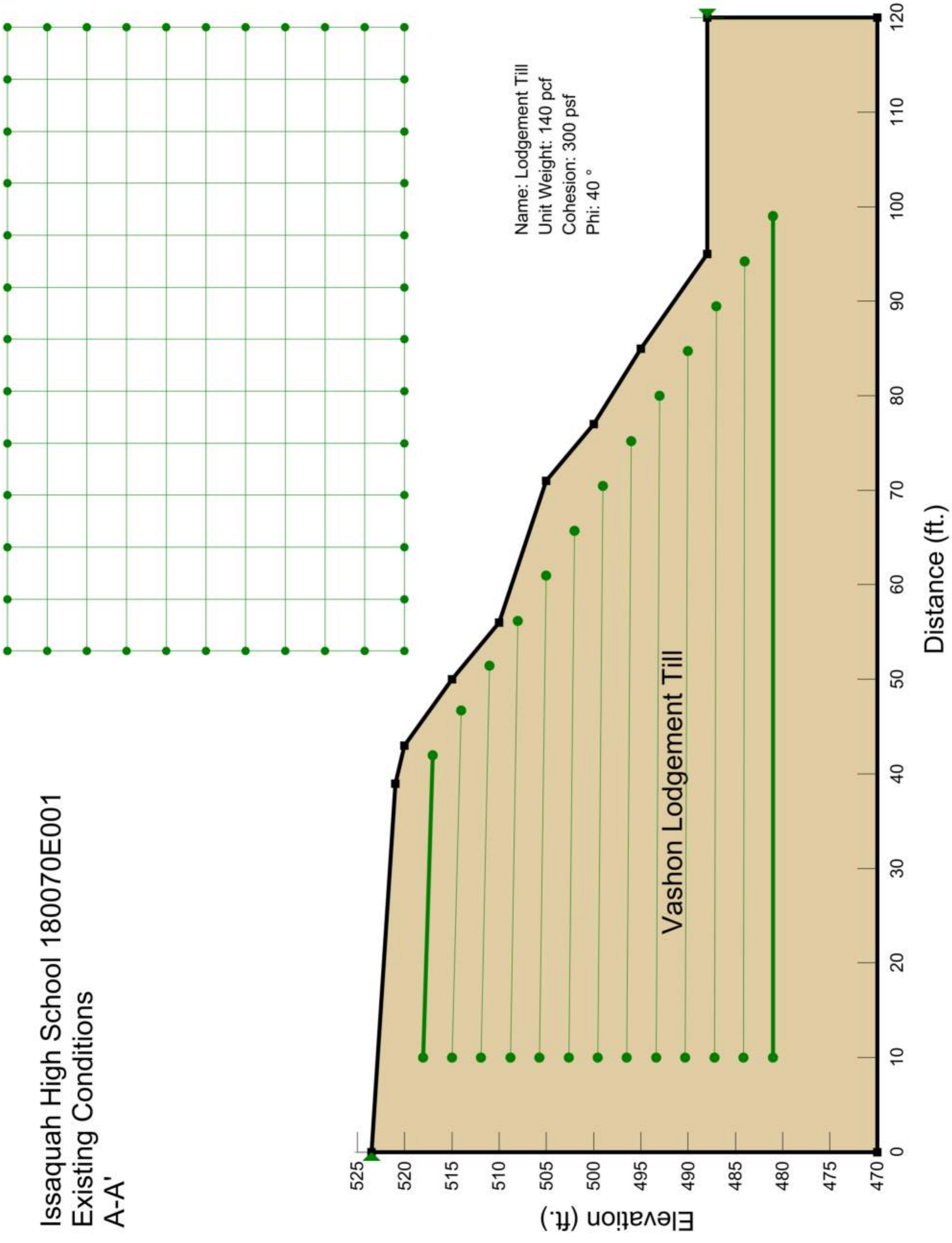
DEPTH (FT.)	SAMPLE NO.	DESCRIPTION	CONSISTENCY/ RELATIVE DENSITY	W (%)	POCKET PEN. (TSF)	REMARKS
1		Brown silty SAND, fine grained, dry, heavy organic inclusions. (SM) (Topsoil)	Loose			
2	1	Brown silty SAND with gravel, fine to medium grained, dry, roots. (SM)	Medium Dense	5.9		
3			Dense			
4			Very Dense			
5	2			9.6		
6						
7		Gray silty SAND with gravel, fine to medium grained, dry to moist, cemented, occasional cobble. (SM)				
8						
9						
10						
11						
12		Test pit terminated at approximately 11 feet. No groundwater seepage observed.				
13						
14						
15						

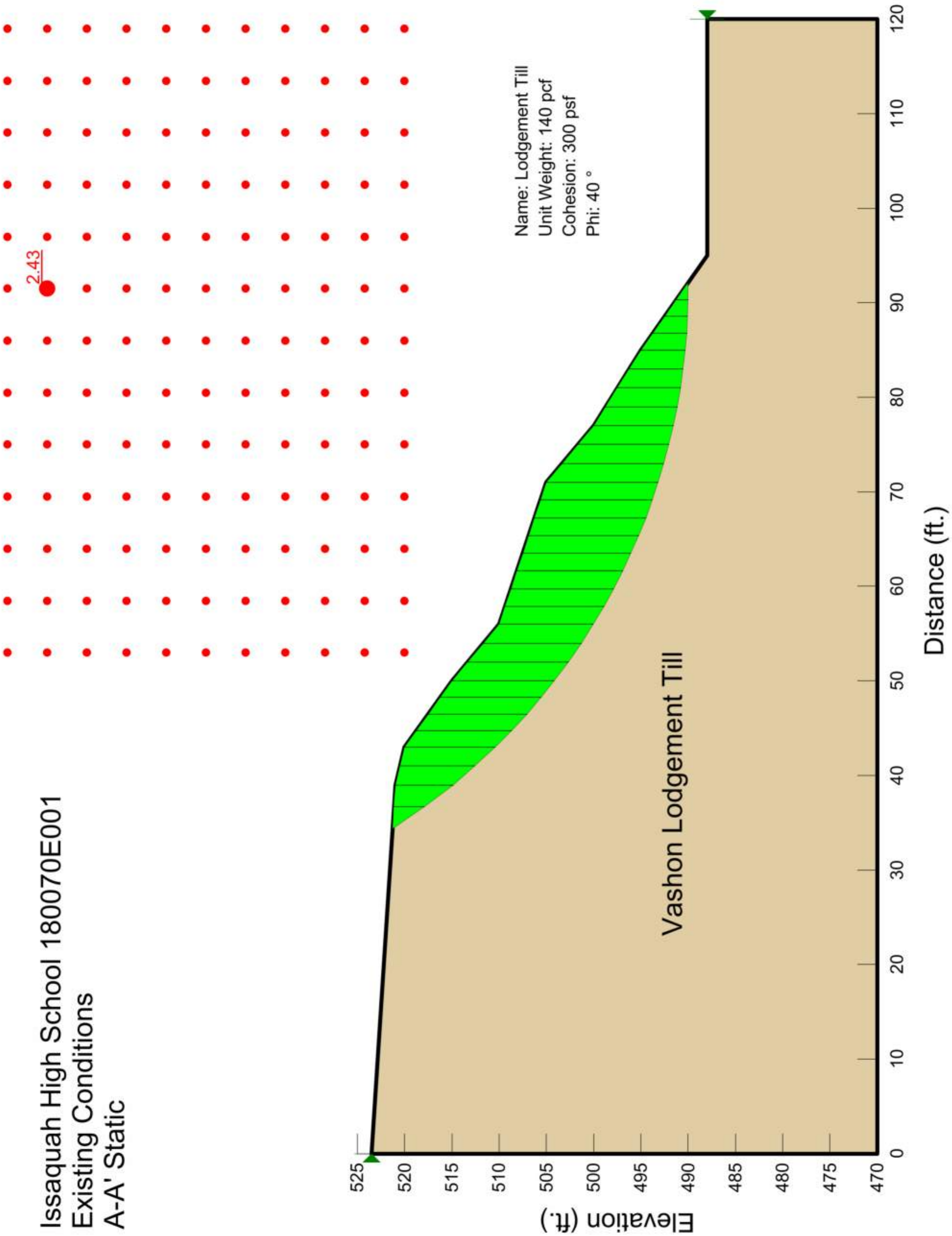
NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

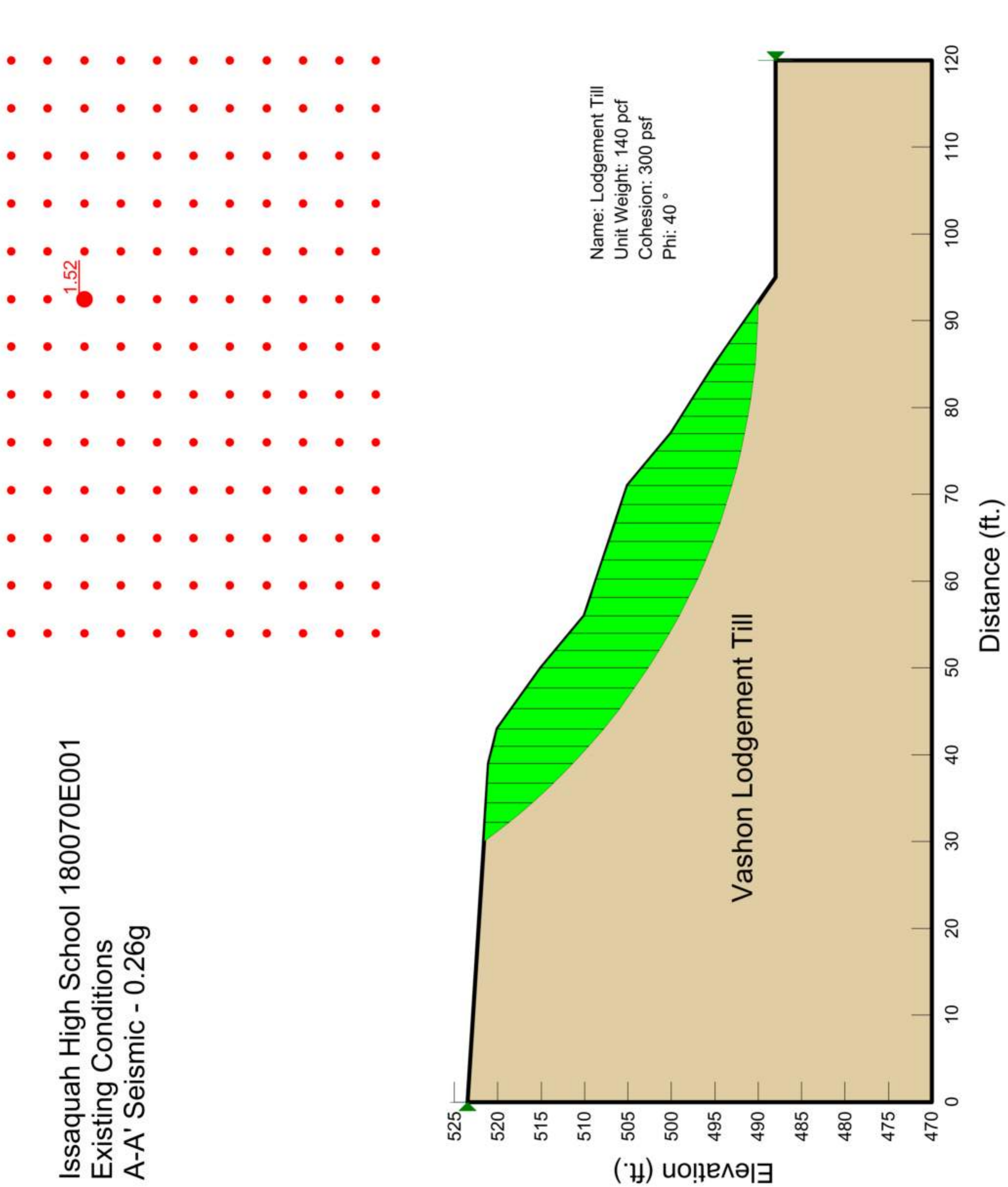
Terra Associates, Inc.
Consultants in Geotechnical Engineering
Geology and
Environmental Earth Sciences

APPENDIX B

SLOPE/W Profiles


Issaquah High School 180070E001
Existing Conditions
A-A'
Name: Lodgement Till
Unit Weight: 140 pcf
Cohesion: 300 psf
Phi: 40 °
Vashon Lodgement Till
Elevation (ft.)
525
520
515
510
505
500
495
490
485
480
475
470
Distance (ft.)
0
10
20
30
40
50
60
70
80
90
100
110
120


Issaquah High School 180070E001
Existing Conditions
A-A' Static
2.43
Name: Lodgement Till
Unit Weight: 140 pcf
Cohesion: 300 psf
Phi: 40 °
Vashon Lodgement Till
Elevation (ft.)
525
520
515
510
505
500
495
490
485
480
475
470
0
10
20
30
40
50
60
70
80
90
100
110
120
Distance (ft.)


Issaquah High School 180070E001
Existing Conditions
A-A' Seismic - 0.26g
1.52
Name: Lodgement Till
Unit Weight: 140 pcf
Cohesion: 300 psf
Phi: 40 °
Vashon Lodgement Till
Elevation (ft.)
525
520
515
510
505
500
495
490
485
480
475
470
Distance (ft.)
0
10
20
30
40
50
60
70
80
90
100
110
120

PRJ19-00008 Attachment 054

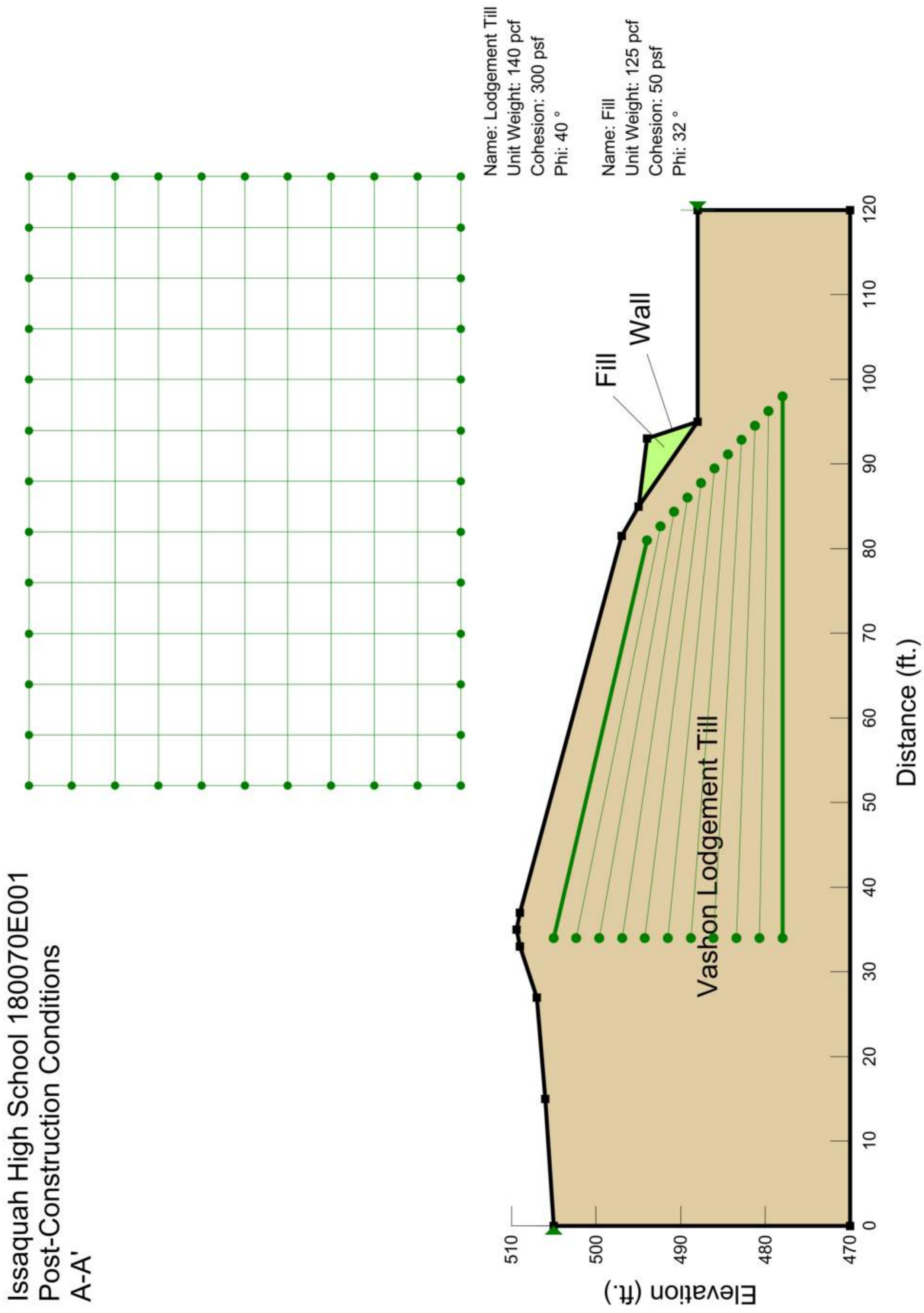
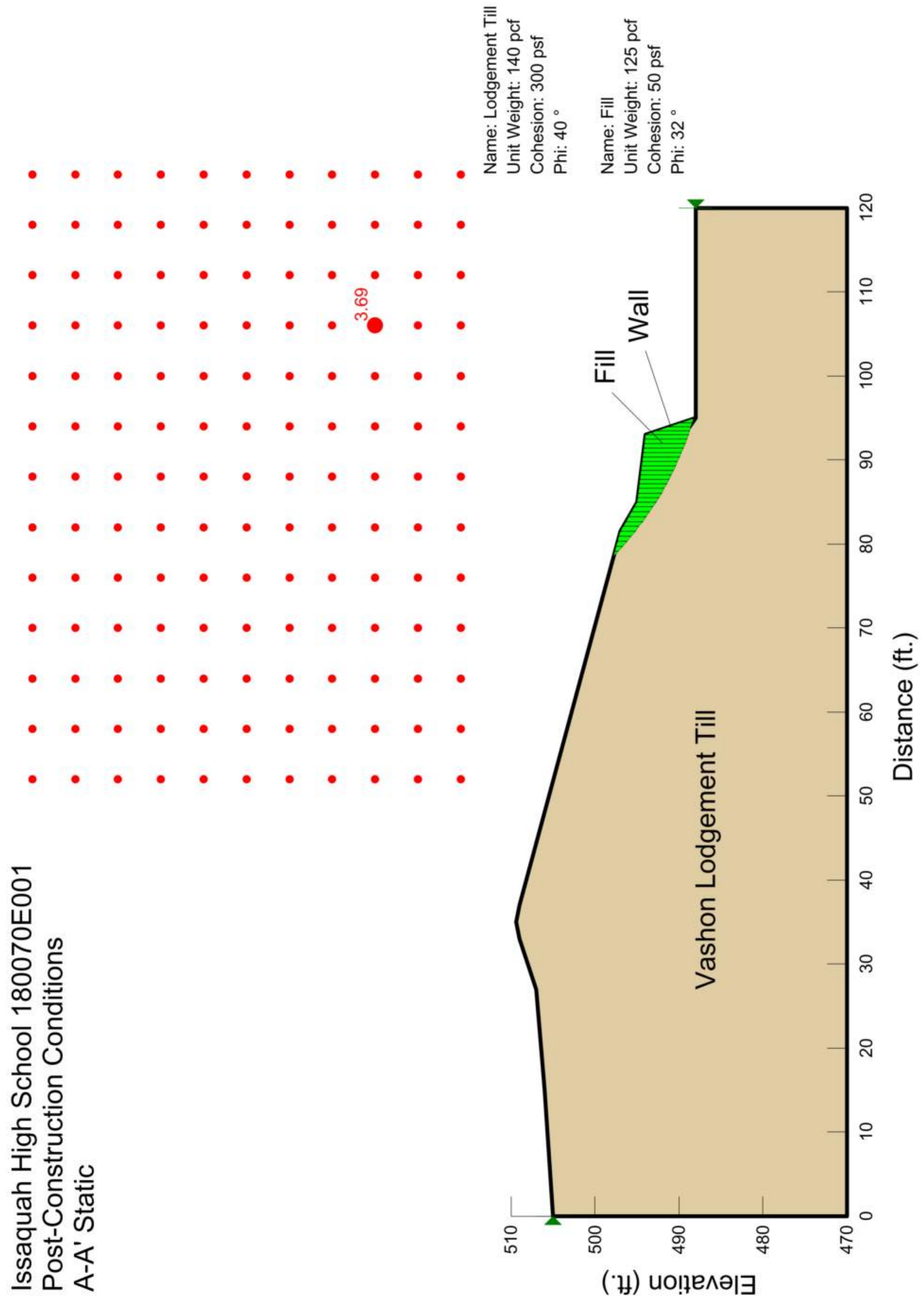
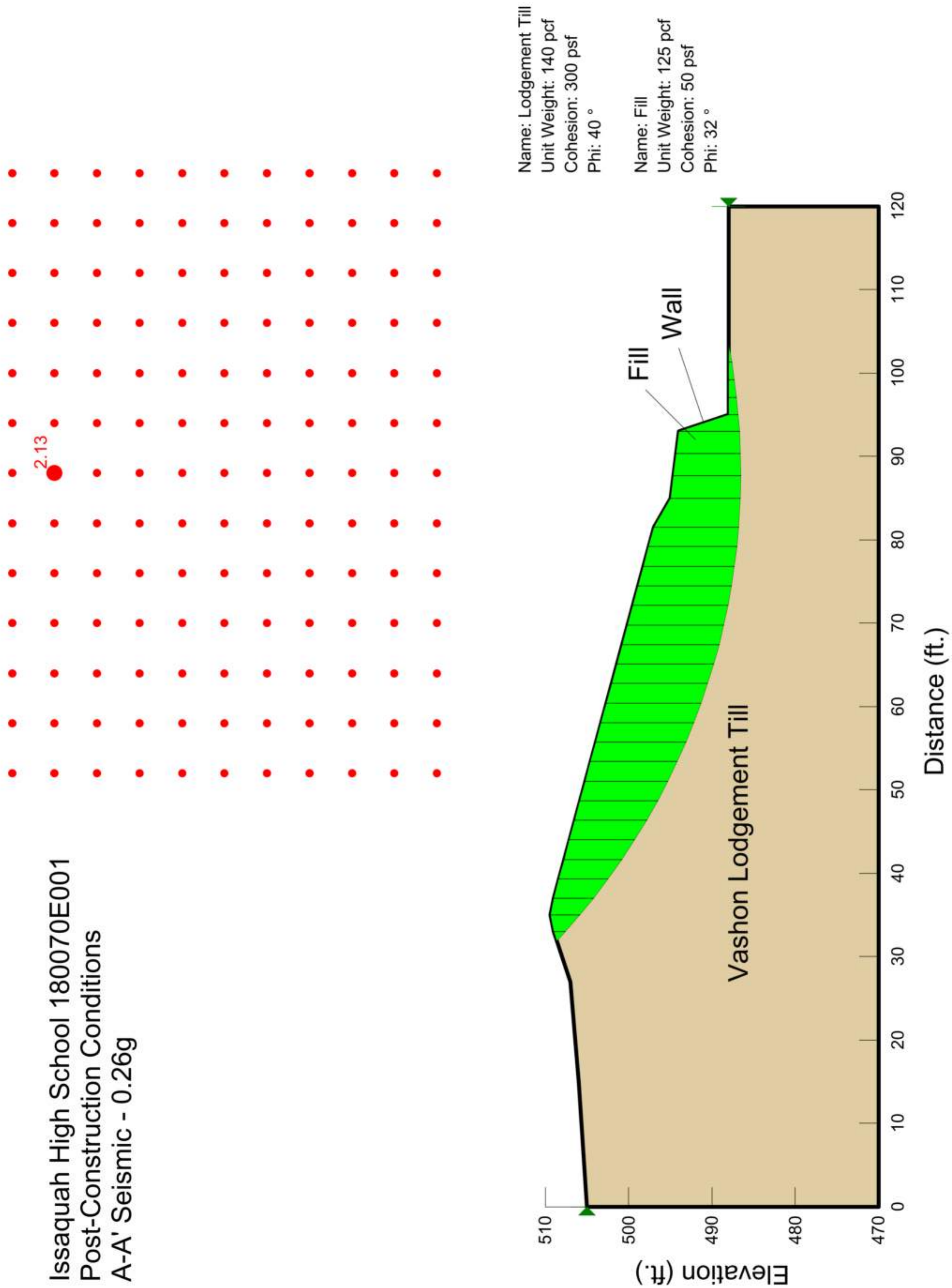
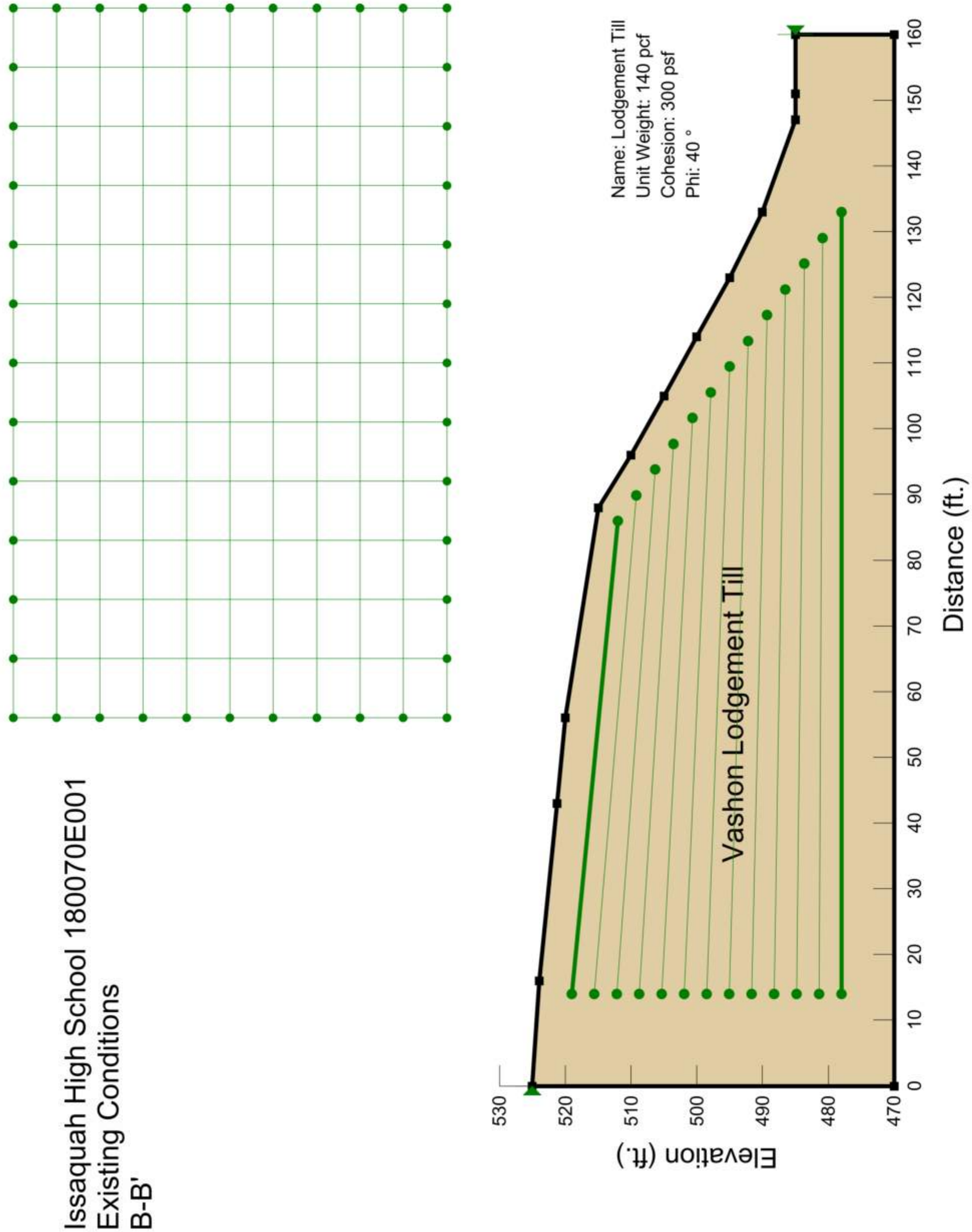


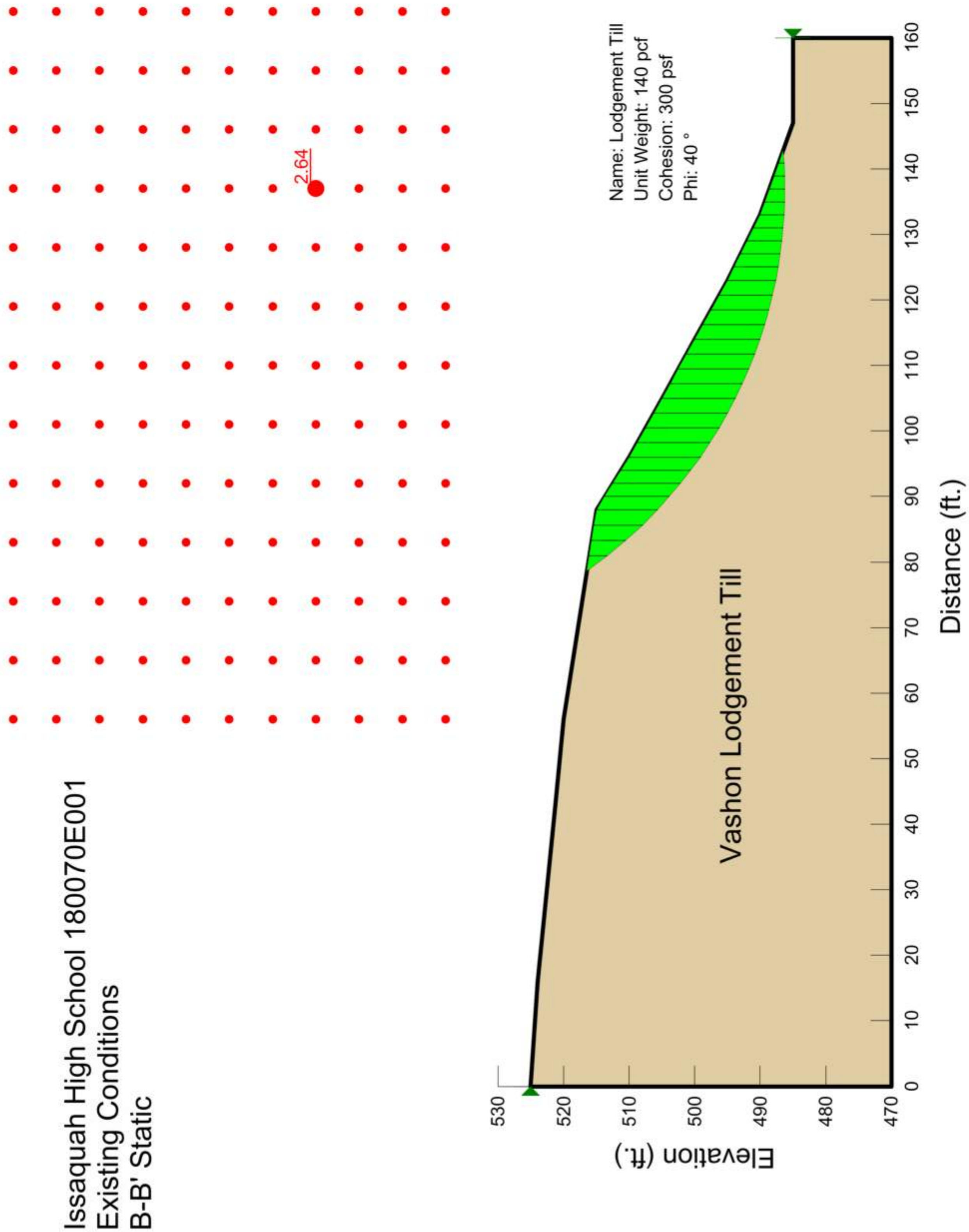
Figure 6-1

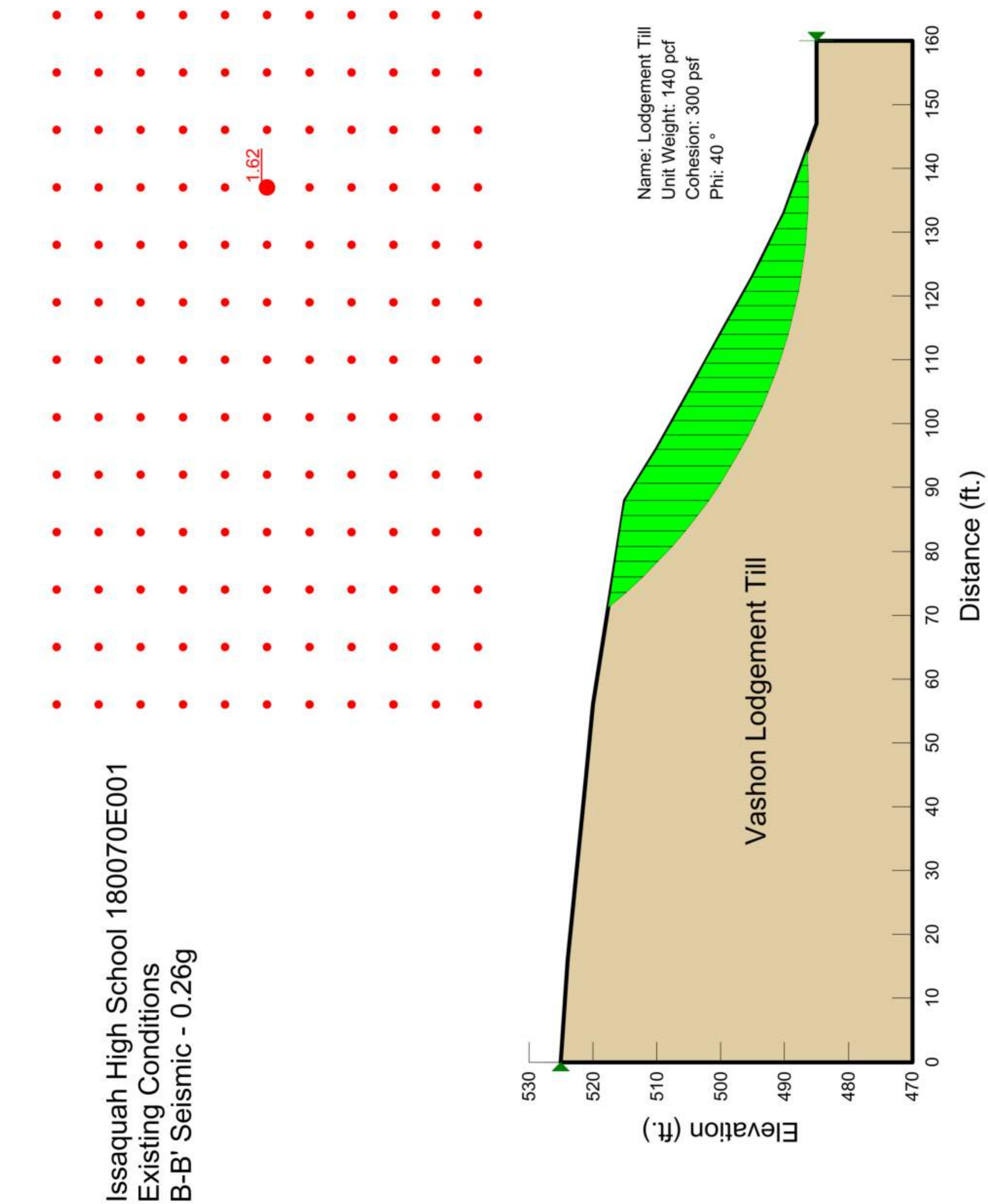

Issaquah High School 180070E001
Post-Construction Conditions
A-A' Static
Name: Lodgement Till
Unit Weight: 140 pcf
Cohesion: 300 psf
Phi: 40 °
Name: Fill
Unit Weight: 125 pcf
Cohesion: 50 psf
Phi: 32 °
3.69
Fill
Wall
Vashon Lodgement Till
Elevation (ft.)
510
500
490
480
470
Distance (ft.)
0
10
20
30
40
50
60
70
80
90
100
110
120

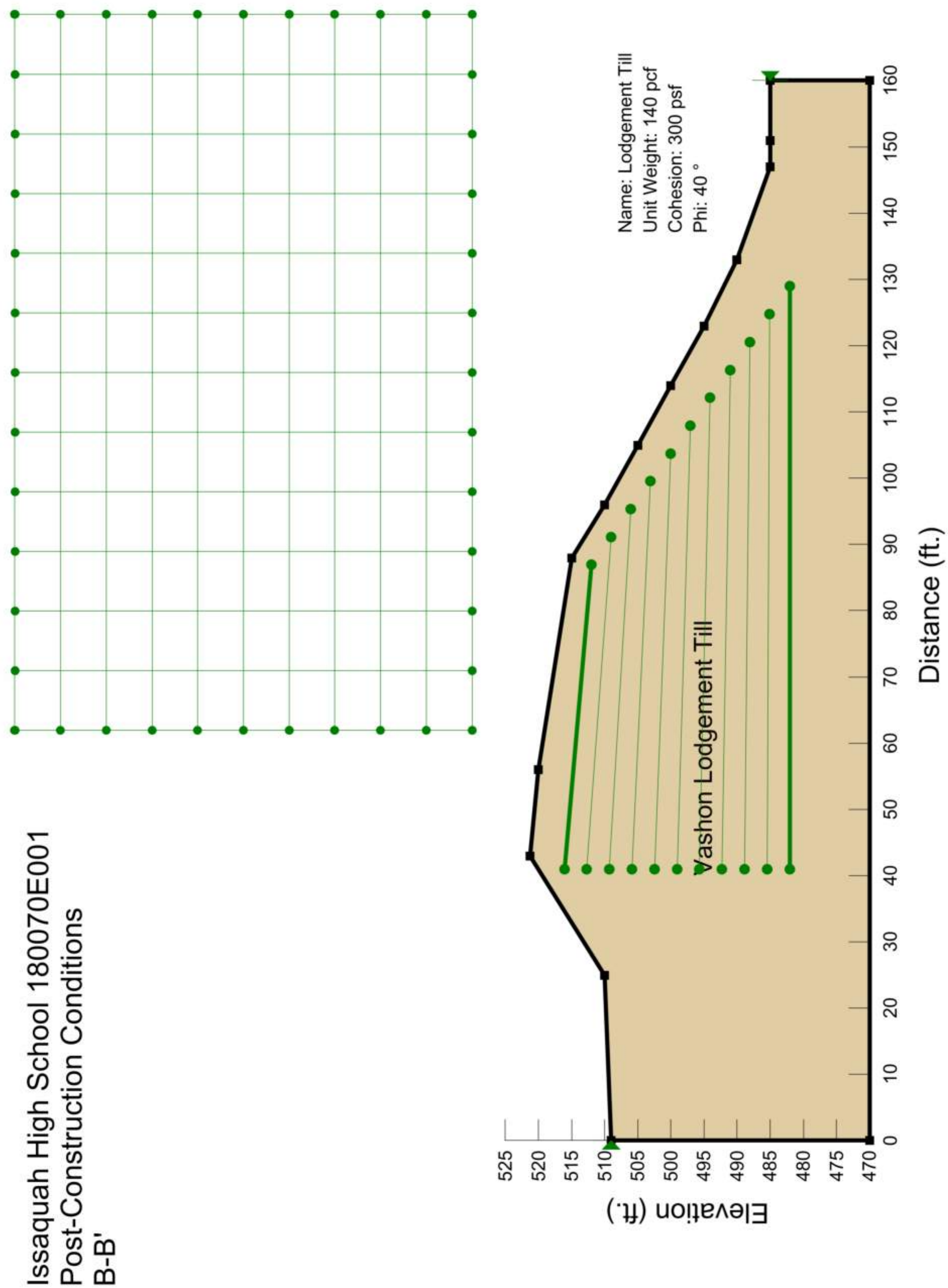
PRJ19-00008 Attachment 054



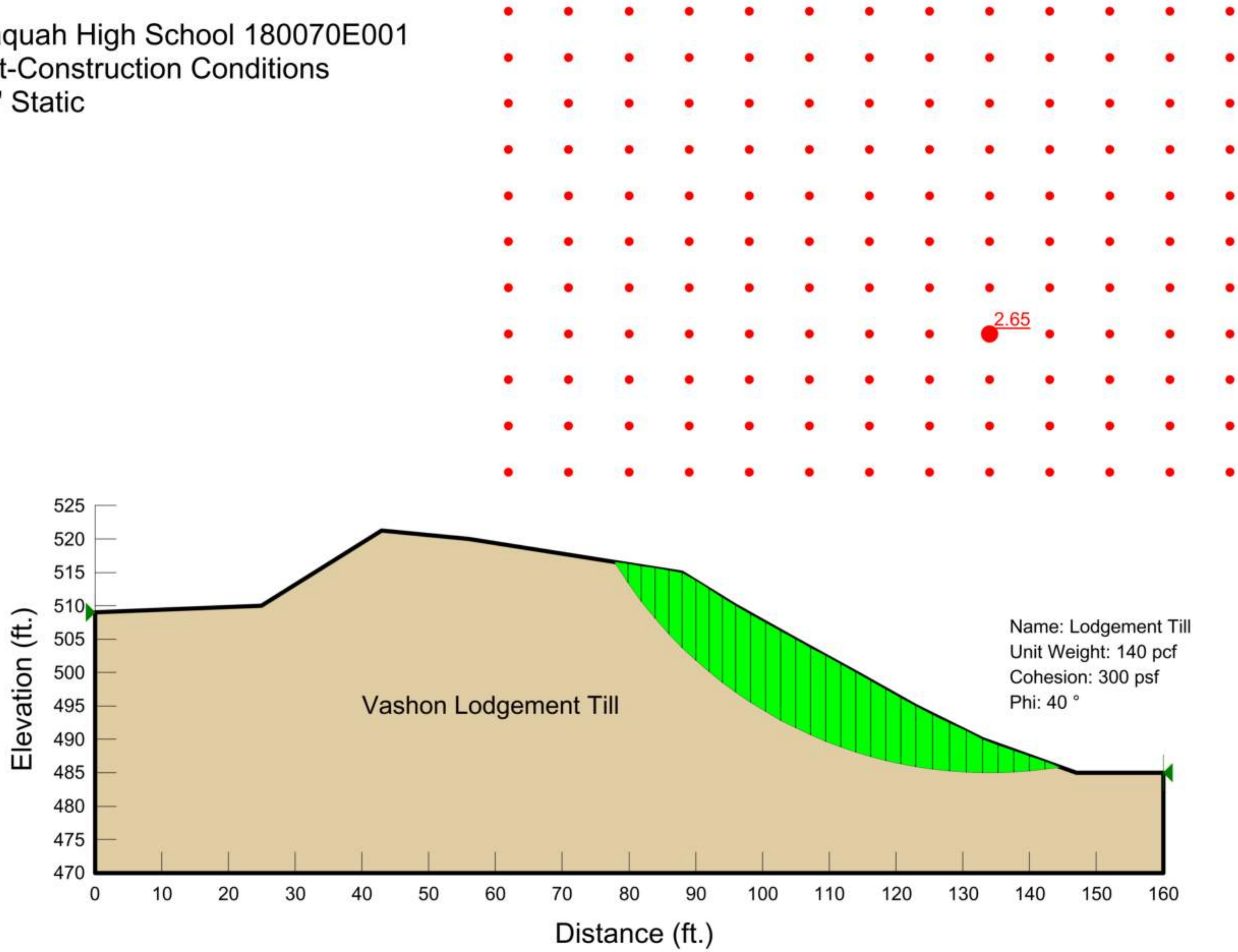

Issaquah High School 180070E001
Existing Conditions
B-B'
Name: Lodgement Till
Unit Weight: 140 pcf
Cohesion: 300 psf
Phi: 40 °
Vashon Lodgement Till
Elevation (ft.)
530
520
510
500
490
480
470
Distance (ft.)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160


Issaquah High School 180070E001
Existing Conditions
B-B' Static
2.64
Name: Lodgement Till
Unit Weight: 140 pcf
Cohesion: 300 psf
Phi: 40 °
Vashon Lodgement Till
Elevation (ft.)
Distance (ft.)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
470
480
490
500
510
520
530

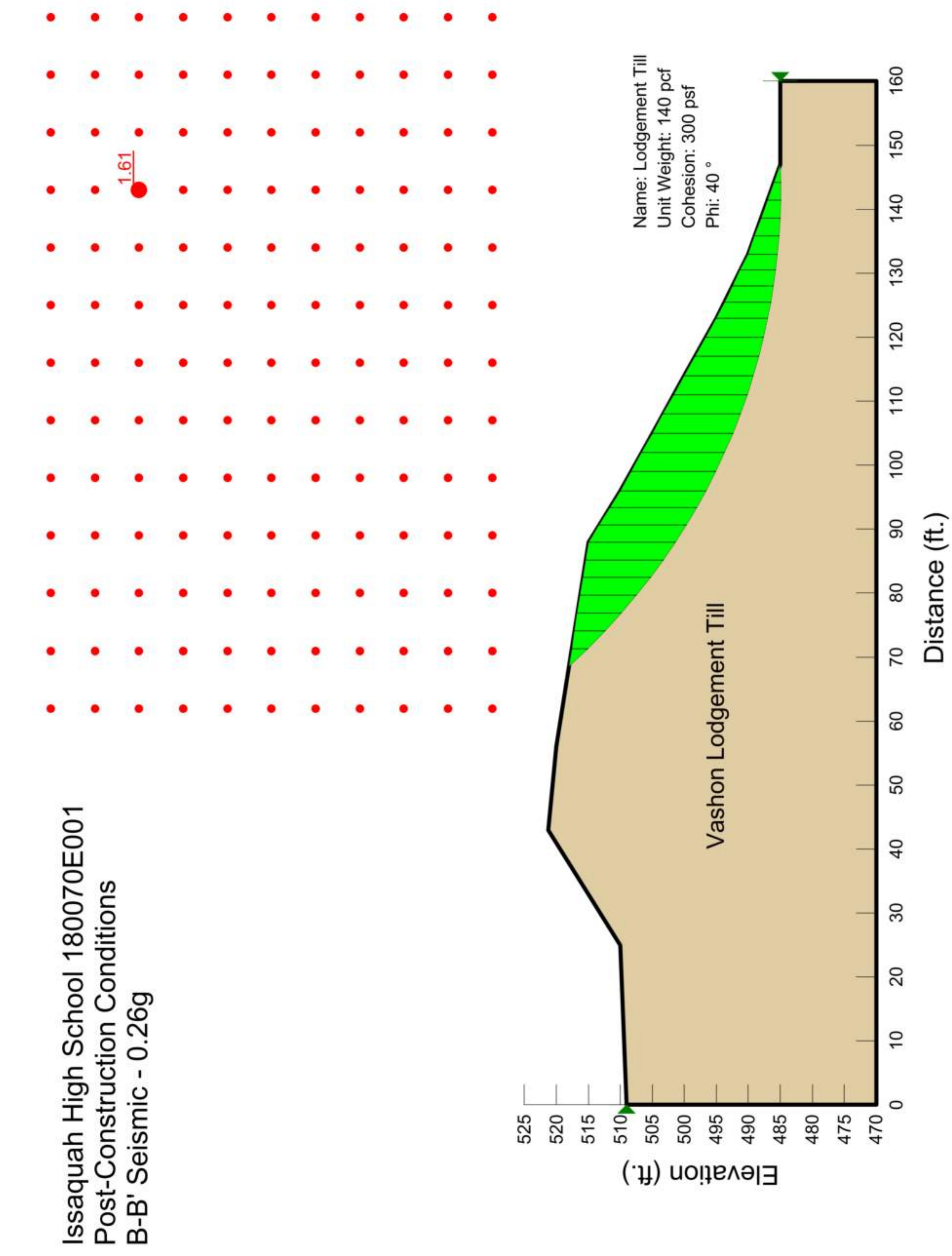

Issaquah High School 180070E001
Existing Conditions
B-B' Seismic - 0.26g
1.62
Name: Lodgement Till
Unit Weight: 140 pcf
Cohesion: 300 psf
Phi: 40 °
Vashon Lodgement Till
Elevation (ft.)
Distance (ft.)
530
520
510
500
490
480
470
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160


Issaquah High School 180070E001
Post-Construction Conditions
B-B'
Name: Lodgement Till
Unit Weight: 140 pcf
Cohesion: 300 psf
Phi: 40 °
Vashon Lodgement Till
Elevation (ft.)
525
520
515
510
505
500
495
490
485
480
475
470
Distance (ft.)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160

Issaquah High School 180070E001
Post-Construction Conditions
B-B' Static



PRJ19-00008 Attachment 054



Section 7

Other Permits

7.0 Other Permits

This project will require other permitting such as NPDES, Building Permits, SEPA, and Site Development.

Section 8

CSWPPP Analysis and Design

8.0 CSWPPP Analysis and Design

A Construction Stormwater Pollution Prevention Plan (CSWPPP) shall be prepared and provided as part of a future final engineering submittal. This CSWPPP will explain and justify the pollution prevention decisions made for the project site and will contain concise information concerning existing site conditions, construction schedules, and pertinent items not contained on the Temporary Erosion and Sediment Control plans. The CSWPPP shall meet the requirements of Section 1.2.5 of the *KCSWDM*.

Section 9

Bond Quantities, Facilities Summaries, and Declarations of Covenant

9.0 Bond Quantities, Facilities Summaries, and Declarations of Covenant

A Flow Control and Water Quality Facility Summary Sheet and Sketch will be provided with a future submittal package with the final civil plans.

The project is not subject to bonding because Issaquah School District No. 411, the owner, is a public agency; therefore, no Bond Quantity Worksheet is provided.

All proposed frontage stormwater improvements are to be owned and maintained by the City of Sammamish because they will be located in the public right-of-way; therefore no declarations of covenant have been prepared.

Section 10

Operations and Maintenance Plan

10.0 Operations and Maintenance Plan

The proposed 228th Ave SE drainage facilities will be publicly owned and maintained by the City of Sammamish. All proposed frontage drainage facilities will be located in the Sammamish public right-of-way therefor no maintenance easement is required. A Storm Maintenance and Operations Manual is provided as Figure 10-1.

10.1 Facility Descriptions

10.1.1 Catch Basins and Manholes

Catch basins collect surface drainage. Catch basins and manholes direct stormwater into storm conveyance pipes. They help prevent downstream drainage problems by trapping sediment and other debris that would otherwise flow downstream with the runoff. It is important to keep catch basins and manholes clean so that accumulated silt is not flushed out during a significant storm. Additionally, if the outflow pipe becomes blocked with debris, surface flooding will occur. All catch basins and manholes should be inspected at least once each year and after major storms.

10.1.2 Conveyance Pipes and Diches

Pipes transport stormwater runoff from the existing and proposed surfaces to the existing downstream discharge location of the proposed frontage improvements site. To work properly, pipes must be kept free of silt and other debris. If pipes become blocked, surface flooding will occur.

10.1.3 BioPod Biofilter

An OldCastle BioPod Biofilter Underground treatment vault is proposed to provide both phosphorus and enhanced water quality treatment for an area equivalent to the new/replaced pollution generating surfaces proposed as part of the frontage improvements; refer to Section 4.0 for additional information on the proposed treatment systems. BioPod Biofilters utilize a biofiltration design for filtration, sorption, and biological uptake to remove pollutants such as total suspended solids, dissolved metals, nutrients, gross solids, trash and debris, as well as petroleum hydrocarbons from stormwater runoff. OldCastle BioPod Biofilter maintenance standards are included in Figure 10-2.

10.1.4 R-Tank Stormwater Detention System

An ACF Environmental R-Tank HD detention system is proposed to provide flow control for the proposed frontage improvements; refer to Section 4.0 for additional information on the flow control standard. R-Tank systems function as underground detention tanks which provide live storage of stormwater and flow control through a controls structure which discharges runoff at a controlled rate from the proposed R-Tank system. A maintenance row is proposed within this R-Tank facility per manufacturer's recommendations. ACF Environmental R-Tank HD detention system maintenance standards are included in Figure 10-3.

10.1.5 Oil/Water Separator

A coalescing plate oil water separator is proposed to provide oil control because the existing project site is considered high-use. Oil/water separators rely on passive mechanisms that take advantage of oil being lighter than water. Oil rises to the surface and must be periodically removed. Coalescing plates reduce the vertical distance oil droplets must rise in order to separate from the stormwater. The film builds up over time until it becomes thick enough to migrate upward because of oil's low density relative to water. When the film reaches the edge of the plate, oil is released as large droplets which rise rapidly to the surface, where the oil accumulates until the unit is maintained. Because the plate pack increases the treatment effectiveness significantly, coalescing plate separators can achieve a specified treatment level with a smaller vault size than a simple baffle separator. A performance goal of 10 to 15 mg/L must be met by removal of oil particles 60 microns and larger.

10.2 Maintenance Requirements

See Figure 10-1 for a copy of the Maintenance Requirements for Flow Control, Conveyance, and Water Quality Facilities. See Figure 10-2 for a copy of the BioPod System Inspecion and Maintenance Guide. See Figure 10-3 for a copy of the R-Tank Operation, Inspection & Maintenance form.

Section 10.0 Figures

APPENDIX A

MAINTENANCE REQUIREMENTS FOR FLOW CONTROL, CONVEYANCE, AND WATER QUALITY FACILITIES

This appendix contains the maintenance requirements for the following typical stormwater control and water quality facilities and components *(ctrl/click ► to follow the link)*:

NO. 3 – DETENTION TANKS AND VAULTS

Maintenance Component	Defect or Problem	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
Site	Trash and debris	Any trash and debris which exceed 1 cubic foot per 1,000 square feet (this is about equal to the amount of trash it would take to fill up one standard size office garbage can). In general, there should be no visual evidence of dumping.	Trash and debris cleared from site.
	Noxious weeds	Any noxious or nuisance vegetation which may constitute a hazard to County personnel or the public.	Noxious and nuisance vegetation removed according to applicable regulations. No danger of noxious vegetation where County personnel or the public might normally be.
	Contaminants and pollution	Any evidence of contaminants or pollution such as oil, gasoline, concrete slurries or paint.	Materials removed and disposed of according to applicable regulations. Source control BMPs implemented if appropriate. No contaminants present other than a surface oil film.
	Grass/groundcover	Grass or groundcover exceeds 18 inches in height.	Grass or groundcover mowed to a height no greater than 6 inches.
Tank or Vault Storage Area	Trash and debris	Any trash and debris accumulated in vault or tank (includes floatables and non-floatables).	No trash or debris in vault.
	Sediment accumulation	Accumulated sediment depth exceeds 10% of the diameter of the storage area for ½ length of storage vault or any point depth exceeds 15% of diameter. Example: 72-inch storage tank would require cleaning when sediment reaches depth of 7 inches for more than ½ length of tank.	All sediment removed from storage area.
Tank Structure	Plugged air vent	Any blockage of the vent.	Tank or vault freely vents.
	Tank bent out of shape	Any part of tank/pipe is bent out of shape more than 10% of its design shape.	Tank repaired or replaced to design.
	Gaps between sections, damaged joints or cracks or tears in wall	A gap wider than ½-inch at the joint of any tank sections or any evidence of soil particles entering the tank at a joint or through a wall.	No water or soil entering tank through joints or walls.
Vault Structure	Damage to wall, frame, bottom, and/or top slab	Cracks wider than ½-inch, any evidence of soil entering the structure through cracks or qualified inspection personnel determines that the vault is not structurally sound.	Vault is sealed and structurally sound.
Inlet/Outlet Pipes	Sediment accumulation	Sediment filling 20% or more of the pipe.	Inlet/outlet pipes clear of sediment.
	Trash and debris	Trash and debris accumulated in inlet/outlet pipes (includes floatables and non-floatables).	No trash or debris in pipes.
	Damaged	Cracks wider than ½-inch at the joint of the inlet/outlet pipes or any evidence of soil entering at the joints of the inlet/outlet pipes.	No cracks more than ¼-inch wide at the joint of the inlet/outlet pipe.

NO. 3 – DETENTION TANKS AND VAULTS

Maintenance Component	Defect or Problem	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
Access Manhole	Cover/lid not in place	Cover/lid is missing or only partially in place. **Any open manhole requires immediate maintenance.**	Manhole access covered.
	Locking mechanism not working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts cannot be seated. Self-locking cover/lid does not work.	Mechanism opens with proper tools.
	Cover/lid difficult to remove	One maintenance person cannot remove cover/lid after applying 80 lbs of lift.	Cover/lid can be removed and reinstalled by one maintenance person.
	Ladder rungs unsafe	Missing rungs, misalignment, rust, or cracks.	Ladder meets design standards. Allows maintenance person safe access.
Large access doors/plate	Damaged or difficult to open	Large access doors or plates cannot be opened/removed using normal equipment.	Replace or repair access door so it can opened as designed.
	Gaps, doesn't cover completely	Large access doors not flat and/or access opening not completely covered.	Doors close flat; covers access opening completely.
	Lifting Rings missing, rusted	Lifting rings not capable of lifting weight of door or plate.	Lifting rings sufficient to lift or remove door or plate.

NO. 4 – CONTROL STRUCTURE/FLOW RESTRICTOR

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Structure	Trash and debris	Trash or debris of more than ½ cubic foot which is located immediately in front of the structure opening or is blocking capacity of the structure by more than 10%.	No Trash or debris blocking or potentially blocking entrance to structure.
		Trash or debris in the structure that exceeds $^{1}/_{3}$ the depth from the bottom of basin to invert the lowest pipe into or out of the basin.	No trash or debris in the structure.
		Deposits of garbage exceeding 1 cubic foot in volume.	No condition present which would attract or support the breeding of insects or rodents.
	Sediment	Sediment exceeds 60% of the depth from the bottom of the structure to the invert of the lowest pipe into or out of the structure or the bottom of the FROP-T section or is within 6 inches of the invert of the lowest pipe into or out of the structure or the bottom of the FROP-T section.	Sump of structure contains no sediment.
	Damage to frame and/or top slab	Corner of frame extends more than ¾ inch past curb face into the street (If applicable).	Frame is even with curb.
		Top slab has holes larger than 2 square inches or cracks wider than ¼ inch.	Top slab is free of holes and cracks.
		Frame not sitting flush on top slab, i.e., separation of more than ¾ inch of the frame from the top slab.	Frame is sitting flush on top slab.
	Cracks in walls or bottom	Cracks wider than ½ inch and longer than 3 feet, any evidence of soil particles entering structure through cracks, or maintenance person judges that structure is unsound.	Structure is sealed and structurally sound.
		Cracks wider than ½ inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering structure through cracks.	No cracks more than $^{1}/_{4}$ inch wide at the joint of inlet/outlet pipe.
	Settlement/ misalignment	Structure has settled more than 1 inch or has rotated more than 2 inches out of alignment.	Basin replaced or repaired to design standards.
	Damaged pipe joints	Cracks wider than ½-inch at the joint of the inlet/outlet pipes or any evidence of soil entering the structure at the joint of the inlet/outlet pipes.	No cracks more than ¼-inch wide at the joint of inlet/outlet pipes.
	Contaminants and pollution	Any evidence of contaminants or pollution such as oil, gasoline, concrete slurries or paint.	Materials removed and disposed of according to applicable regulations. Source control BMPs implemented if appropriate. No contaminants present other than a surface oil film.
	Ladder rungs missing or unsafe	Ladder is unsafe due to missing rungs, misalignment, rust, cracks, or sharp edges.	Ladder meets design standards and allows maintenance person safe access.
FROP-T Section	Damage	T section is not securely attached to structure wall and outlet pipe structure should support at least 1,000 lbs of up or down pressure.	T section securely attached to wall and outlet pipe.
		Structure is not in upright position (allow up to 10% from plumb).	Structure in correct position.
		Connections to outlet pipe are not watertight or show signs of deteriorated grout.	Connections to outlet pipe are water tight; structure repaired or replaced and works as designed.
		Any holes—other than designed holes—in the structure.	Structure has no holes other than designed holes.

NO. 4 – CONTROL STRUCTURE/FLOW RESTRICTOR

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Cleanout Gate	Damaged or missing	Cleanout gate is missing.	Replace cleanout gate.
		Cleanout gate is not watertight.	Gate is watertight and works as designed.
		Gate cannot be moved up and down by one maintenance person.	Gate moves up and down easily and is watertight.
		Chain/rod leading to gate is missing or damaged.	Chain is in place and works as designed.
Orifice Plate	Damaged or missing	Control device is not working properly due to missing, out of place, or bent orifice plate.	Plate is in place and works as designed.
	Obstructions	Any trash, debris, sediment, or vegetation blocking the plate.	Plate is free of all obstructions and works as designed.
Overflow Pipe	Obstructions	Any trash or debris blocking (or having the potential of blocking) the overflow pipe.	Pipe is free of all obstructions and works as designed.
	Deformed or damaged lip	Lip of overflow pipe is bent or deformed.	Overflow pipe does not allow overflow at an elevation lower than design
Inlet/Outlet Pipe	Sediment accumulation	Sediment filling 20% or more of the pipe.	Inlet/outlet pipes clear of sediment.
	Trash and debris	Trash and debris accumulated in inlet/outlet pipes (includes floatables and non-floatables).	No trash or debris in pipes.
	Damaged	Cracks wider than ½-inch at the joint of the inlet/outlet pipes or any evidence of soil entering at the joints of the inlet/outlet pipes.	No cracks more than ¼-inch wide at the joint of the inlet/outlet pipe.
Metal Grates (If Applicable)	Unsafe grate opening	Grate with opening wider than $^{7}/_{8}$ inch.	Grate opening meets design standards.
	Trash and debris	Trash and debris that is blocking more than 20% of grate surface.	Grate free of trash and debris. footnote to guidelines for disposal
	Damaged or missing	Grate missing or broken member(s) of the grate.	Grate is in place and meets design standards.
Manhole Cover/Lid	Cover/lid not in place	Cover/lid is missing or only partially in place. **Any open structure requires urgent maintenance**.	Cover/lid protects opening to structure.
	Locking mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts cannot be seated. Self-locking cover/lid does not work.	Mechanism opens with proper tools.
	Cover/lid difficult to Remove	One maintenance person cannot remove cover/lid after applying 80 lbs. of lift.	Cover/lid can be removed and reinstalled by one maintenance person.

NO. 5 – CATCH BASINS AND MANHOLES

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Structure	Sediment	Sediment exceeds 60% of the depth from the bottom of the catch basin to the invert of the lowest pipe into or out of the catch basin or is within 6 inches of the invert of the lowest pipe into or out of the catch basin.	Sump of catch basin contains no sediment.
	Trash and debris	Trash or debris of more than ½ cubic foot which is located immediately in front of the catch basin opening or is blocking capacity of the catch basin by more than 10%.	No Trash or debris blocking or potentially blocking entrance to catch basin.
		Trash or debris in the catch basin that exceeds $^1/_3$ the depth from the bottom of basin to invert the lowest pipe into or out of the basin.	No trash or debris in the catch basin.
		Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g., methane).	No dead animals or vegetation present within catch basin.
		Deposits of garbage exceeding 1 cubic foot in volume.	No condition present which would attract or support the breeding of insects or rodents.
	Damage to frame and/or top slab	Corner of frame extends more than ¾ inch past curb face into the street (If applicable).	Frame is even with curb.
		Top slab has holes larger than 2 square inches or cracks wider than ¼ inch.	Top slab is free of holes and cracks.
		Frame not sitting flush on top slab, i.e., separation of more than ¾ inch of the frame from the top slab.	Frame is sitting flush on top slab.
	Cracks in walls or bottom	Cracks wider than ½ inch and longer than 3 feet, any evidence of soil particles entering catch basin through cracks, or maintenance person judges that catch basin is unsound.	Catch basin is sealed and is structurally sound.
		Cracks wider than ½ inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering catch basin through cracks.	No cracks more than $^1/_4$ inch wide at the joint of inlet/outlet pipe.
	Settlement/ misalignment	Catch basin has settled more than 1 inch or has rotated more than 2 inches out of alignment.	Basin replaced or repaired to design standards.
	Damaged pipe joints	Cracks wider than ½-inch at the joint of the inlet/outlet pipes or any evidence of soil entering the catch basin at the joint of the inlet/outlet pipes.	No cracks more than ¼-inch wide at the joint of inlet/outlet pipes.
	Contaminants and pollution	Any evidence of contaminants or pollution such as oil, gasoline, concrete slurries or paint.	Materials removed and disposed of according to applicable regulations. Source control BMPs implemented if appropriate. No contaminants present other than a surface oil film.
Inlet/Outlet Pipe	Sediment accumulation	Sediment filling 20% or more of the pipe.	Inlet/outlet pipes clear of sediment.
	Trash and debris	Trash and debris accumulated in inlet/outlet pipes (includes floatables and non-floatables).	No trash or debris in pipes.
	Damaged	Cracks wider than ½-inch at the joint of the inlet/outlet pipes or any evidence of soil entering at the joints of the inlet/outlet pipes.	No cracks more than ¼-inch wide at the joint of the inlet/outlet pipe.

NO. 5 – CATCH BASINS AND MANHOLES

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Metal Grates (Catch Basins)	Unsafe grate opening	Grate with opening wider than $^7/_8$ inch.	Grate opening meets design standards.
	Trash and debris	Trash and debris that is blocking more than 20% of grate surface.	Grate free of trash and debris. footnote to guidelines for disposal
	Damaged or missing	Grate missing or broken member(s) of the grate. **Any open structure requires urgent maintenance**.	Grate is in place and meets design standards.
Manhole Cover/Lid	Cover/lid not in place	Cover/lid is missing or only partially in place. **Any open structure requires urgent maintenance**.	Cover/lid protects opening to structure.
	Locking mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts cannot be seated. Self-locking cover/lid does not work.	Mechanism opens with proper tools.
	Cover/lid difficult to Remove	One maintenance person cannot remove cover/lid after applying 80 lbs. of lift.	Cover/lid can be removed and reinstalled by one maintenance person.

NO. 6 – CONVEYANCE PIPES AND DITCHES

Maintenance Component	Defect or Problem	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
Pipes	Sediment & debris accumulation	Accumulated sediment or debris that exceeds 20% of the diameter of the pipe.	Water flows freely through pipes.
	Vegetation/roots	Vegetation/roots that reduce free movement of water through pipes.	Water flows freely through pipes.
	Contaminants and pollution	Any evidence of contaminants or pollution such as oil, gasoline, concrete slurries or paint.	Materials removed and disposed of according to applicable regulations. Source control BMPs implemented if appropriate. No contaminants present other than a surface oil film.
	Damage to protective coating or corrosion	Protective coating is damaged; rust or corrosion is weakening the structural integrity of any part of pipe.	Pipe repaired or replaced.
	Damaged	Any dent that decreases the cross section area of pipe by more than 20% or is determined to have weakened structural integrity of the pipe.	Pipe repaired or replaced.
Ditches	Trash and debris	Trash and debris exceeds 1 cubic foot per 1,000 square feet of ditch and slopes.	Trash and debris cleared from ditches.
	Sediment accumulation	Accumulated sediment that exceeds 20% of the design depth.	Ditch cleaned/flushed of all sediment and debris so that it matches design.
	Noxious weeds	Any noxious or nuisance vegetation which may constitute a hazard to County personnel or the public.	Noxious and nuisance vegetation removed according to applicable regulations. No danger of noxious vegetation where County personnel or the public might normally be.
	Contaminants and pollution	Any evidence of contaminants or pollution such as oil, gasoline, concrete slurries or paint.	Materials removed and disposed of according to applicable regulations. Source control BMPs implemented if appropriate. No contaminants present other than a surface oil film.
	Vegetation	Vegetation that reduces free movement of water through ditches.	Water flows freely through ditches.
	Erosion damage to slopes	Any erosion observed on a ditch slope.	Slopes are not eroding.
	Rock lining out of place or missing (If Applicable)	One layer or less of rock exists above native soil area 5 square feet or more, any exposed native soil.	Replace rocks to design standards.

NO. 7 – DEBRIS BARRIERS (E.G., TRASH RACKS)

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed.
Site	Trash and debris	Trash or debris plugging more than 20% of the area of the barrier.	Barrier clear to receive capacity flow.
	Sediment accumulation	Sediment accumulation of greater than 20% of the area of the barrier	Barrier clear to receive capacity flow.
Structure	Cracked broken or loose	Structure which bars attached to is damaged - pipe is loose or cracked or concrete structure is cracked, broken of loose.	Structure barrier attached to is sound.
Bars	Bar spacing	Bar spacing exceeds 6 inches.	Bars have at most 6 inches spacing.
	Damaged or missing bars	Bars are bent out of shape more than 3 inches.	Bars in place with no bends more than ¾ inch.
		Bars are missing or entire barrier missing.	Bars in place according to design.
		Bars are loose and rust is causing 50% deterioration to any part of barrier.	Repair or replace barrier to design standards.

NO. 8 – ENERGY DISSIPATERS

Maintenance Component	Defect or Problem	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed.
Site	Trash and debris	Trash and/or debris accumulation.	Dissipater clear of trash and/or debris.
	Contaminants and pollution	Any evidence of contaminants or pollution such as oil, gasoline, concrete slurries or paint.	Materials removed and disposed of according to applicable regulations. Source control BMPs implemented if appropriate. No contaminants present other than a surface oil film.
Rock Pad	Missing or moved Rock	Only one layer of rock exists above native soil in area five square feet or larger or any exposure of native soil.	Rock pad prevents erosion.
Dispersion Trench	Pipe plugged with sediment	Accumulated sediment that exceeds 20% of the design depth.	Pipe cleaned/flushed so that it matches design.
	Not discharging water properly	Visual evidence of water discharging at concentrated points along trench (normal condition is a “sheet flow” of water along trench).	Water discharges from feature by sheet flow.
	Perforations plugged.	Over 1/4 of perforations in pipe are plugged with debris or sediment.	Perforations freely discharge flow.
	Water flows out top of “distributor” catch basin.	Water flows out of distributor catch basin during any storm less than the design storm.	No flow discharges from distributor catch basin.
	Receiving area over-saturated	Water in receiving area is causing or has potential of causing landslide problems.	No danger of landslides.
Gabions	Damaged mesh	Mesh of gabion broken, twisted or deformed so structure is weakened or rock may fall out.	Mesh is intact, no rock missing.
	Corrosion	Gabion mesh shows corrosion through more than ¼ of its gage.	All gabion mesh capable of containing rock and retaining designed form.
	Collapsed or deformed baskets	Gabion basket shape deformed due to any cause.	All gabion baskets intact, structure stands as designed.
	Missing rock	Any rock missing that could cause gabion to loose structural integrity.	No rock missing.
Manhole/Chamber	Worn or damaged post, baffles or side of chamber	Structure dissipating flow deteriorates to ½ or original size or any concentrated worn spot exceeding one square foot which would make structure unsound.	Structure is in no danger of failing.
	Damage to wall, frame, bottom, and/or top slab	Cracks wider than ½-inch or any evidence of soil entering the structure through cracks, or maintenance inspection personnel determines that the structure is not structurally sound.	Manhole/chamber is sealed and structurally sound.
	Damaged pipe joints	Cracks wider than ½-inch at the joint of the inlet/outlet pipes or any evidence of soil entering the structure at the joint of the inlet/outlet pipes.	No soil or water enters and no water discharges at the joint of inlet/outlet pipes.

NO. 9 – FENCING

Maintenance Component	Defect or Problem	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
Site	Erosion or holes under fence	Erosion or holes more than 4 inches high and 12-18 inches wide permitting access through an opening under a fence.	No access under the fence.
Wood Posts, Boards and Cross Members	Missing or damaged parts	Missing or broken boards, post out of plumb by more than 6 inches or cross members broken	No gaps on fence due to missing or broken boards, post plumb to within 1½ inches, cross members sound.
	Weakened by rotting or insects	Any part showing structural deterioration due to rotting or insect damage	All parts of fence are structurally sound.
	Damaged or failed post foundation	Concrete or metal attachments deteriorated or unable to support posts.	Post foundation capable of supporting posts even in strong wind.
Metal Posts, Rails and Fabric	Damaged parts	Post out of plumb more than 6 inches.	Post plumb to within 1½ inches.
		Top rails bent more than 6 inches.	Top rail free of bends greater than 1 inch.
		Any part of fence (including post, top rails, and fabric) more than 1 foot out of design alignment.	Fence is aligned and meets design standards.
		Missing or loose tension wire.	Tension wire in place and holding fabric.
	Deteriorated paint or protective coating	Part or parts that have a rusting or scaling condition that has affected structural adequacy.	Structurally adequate posts or parts with a uniform protective coating.
	Openings in fabric	Openings in fabric are such that an 8-inch diameter ball could fit through.	Fabric mesh openings within 50% of grid size.

NO. 10 – GATES/BOLLARDS/ACCESS BARRIERS

Maintenance Component	Defect or Problem	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
Chain Link Fencing Gate	Damaged or missing members	Missing gate.	Gates in place.
		Broken or missing hinges such that gate cannot be easily opened and closed by a maintenance person.	Hinges intact and lubed. Gate is working freely.
		Gate is out of plumb more than 6 inches and more than 1 foot out of design alignment.	Gate is aligned and vertical.
		Missing stretcher bar, stretcher bands, and ties.	Stretcher bar, bands, and ties in place.
	Locking mechanism does not lock gate	Locking device missing, no-functioning or does not link to all parts.	Locking mechanism prevents opening of gate.
	Openings in fabric	Openings in fabric are such that an 8-inch diameter ball could fit through.	Fabric mesh openings within 50% of grid size.
Bar Gate	Damaged or missing cross bar	Cross bar does not swing open or closed, is missing or is bent to where it does not prevent vehicle access.	Cross bar swings fully open and closed and prevents vehicle access.
	Locking mechanism does not lock gate	Locking device missing, no-functioning or does not link to all parts.	Locking mechanism prevents opening of gate.
	Support post damaged	Support post does not hold cross bar up.	Cross bar held up preventing vehicle access into facility.
Bollards	Damaged or missing	Bollard broken, missing, does not fit into support hole or hinge broken or missing.	No access for motorized vehicles to get into facility.
	Does not lock	Locking assembly or lock missing or cannot be attached to lock bollard in place.	No access for motorized vehicles to get into facility.
Boulders	Dislodged	Boulders not located to prevent motorized vehicle access.	No access for motorized vehicles to get into facility.
	Circumvented	Motorized vehicles going around or between boulders.	No access for motorized vehicles to get into facility.

NO. 11 – GROUNDS (LANDSCAPING)

Maintenance Component	Defect or Problem	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
Site	Trash or litter	Any trash and debris which exceed 1 cubic foot per 1,000 square feet (this is about equal to the amount of trash it would take to fill up one standard size office garbage can). In general, there should be no visual evidence of dumping.	Trash and debris cleared from site.
	Noxious weeds	Any noxious or nuisance vegetation which may constitute a hazard to County personnel or the public.	Noxious and nuisance vegetation removed according to applicable regulations. No danger of noxious vegetation where County personnel or the public might normally be.
	Contaminants and pollution	Any evidence of contaminants or pollution such as oil, gasoline, concrete slurries or paint.	Materials removed and disposed of according to applicable regulations. Source control BMPs implemented if appropriate. No contaminants present other than a surface oil film.
	Grass/groundcover	Grass or groundcover exceeds 18 inches in height.	Grass or groundcover mowed to a height no greater than 6 inches.
Trees and Shrubs	Hazard	Any tree or limb of a tree identified as having a potential to fall and cause property damage or threaten human life. **A hazard tree identified by a qualified arborist must be removed as soon as possible.**	No hazard trees in facility.
	Damaged	Limbs or parts of trees or shrubs that are split or broken which affect more than 25% of the total foliage of the tree or shrub.	Trees and shrubs with less than 5% of total foliage with split or broken limbs.
		Trees or shrubs that have been blown down or knocked over.	No blown down vegetation or knocked over vegetation. Trees or shrubs free of injury.
		Trees or shrubs which are not adequately supported or are leaning over, causing exposure of the roots.	Tree or shrub in place and adequately supported; dead or diseased trees removed.

NO. 12 – ACCESS ROADS

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Site	Trash and debris	Trash and debris exceeds 1 cubic foot per 1,000 square feet (i.e., trash and debris would fill up one standards size garbage can).	Roadway drivable by maintenance vehicles.
		Debris which could damage vehicle tires or prohibit use of road.	Roadway drivable by maintenance vehicles.
	Contaminants and pollution	Any evidence of contaminants or pollution such as oil, gasoline, concrete slurries or paint.	Materials removed and disposed of according to applicable regulations. Source control BMPs implemented if appropriate. No contaminants present other than a surface oil film.
	Blocked roadway	Any obstruction which reduces clearance above road surface to less than 14 feet.	Roadway overhead clear to 14 feet high.
		Any obstruction restricting the access to a 10- to 12 foot width for a distance of more than 12 feet or any point restricting access to less than a 10 foot width.	At least 12-foot of width on access road.
Road Surface	Erosion, settlement, potholes, soft spots, ruts	Any surface defect which hinders or prevents maintenance access.	Road drivable by maintenance vehicles.
	Vegetation on road surface	Trees or other vegetation prevent access to facility by maintenance vehicles.	Maintenance vehicles can access facility.
Shoulders and Ditches	Erosion	Erosion within 1 foot of the roadway more than 8 inches wide and 6 inches deep.	Shoulder free of erosion and matching the surrounding road.
	Weeds and brush	Weeds and brush exceed 18 inches in height or hinder maintenance access.	Weeds and brush cut to 2 inches in height or cleared in such a way as to allow maintenance access.
Modular Grid Pavement	Contaminants and pollution	Any evidence of contaminants or pollution such as oil, gasoline, concrete slurries or paint.	Materials removed and disposed of according to applicable regulations. Source control BMPs implemented if appropriate. No contaminants present other than a surface oil film.
	Damaged or missing	Access surface compacted because of broken on missing modular block.	Access road surface restored so road infiltrates.

Oldcastle Infrastructure™
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BIOPOD™ SYSTEM

WITH STORMMIX™ MEDIA

Inspection and Maintenance Guide

Water

BioPod™ Biofilter with StormMix™ Biofiltration Media

Description

The BioPod™ Biofilter System (BioPod) is a stormwater biofiltration treatment system used to remove pollutants from stormwater runoff. Impervious surfaces and other urban and suburban landscapes generate a variety of contaminants that can enter stormwater and pollute downstream receiving waters unless treatment is provided. The BioPod system uses proprietary StormMix™ biofiltration media to capture and retain pollutants including total suspended solids (TSS), metals, nutrients, gross solids, trash and debris as well as petroleum hydrocarbons.

Function

The BioPod system uses engineered, high-flow rate filter media to remove stormwater pollutants, allowing for a smaller footprint than conventional bioretention systems. Contained within a compact precast concrete vault, the BioPod system consists of a biofiltration chamber and an optional integrated high-flow bypass with a contoured inlet rack to minimize scour. The biofiltration chamber is filled with horizontal layers of aggregate (which may or may not include an underdrain), biofiltration media and mulch. Stormwater passes vertically down through the mulch and biofiltration media for treatment. The mulch provides pretreatment by retaining most of the solids or sediment. The biofiltration media provides further treatment by retaining finer sediment and dissolved pollutants. The aggregate allows the media bed to drain evenly for discharge through an underdrain pipe or by infiltration.

Configuration

The BioPod system can be configured with either an internal or external bypass. The internal bypass allows both water quality and bypass flows to enter the treatment vault. The water quality flows are directed to the biofiltration chamber while the excess flows are diverted over the bypass weir without entering the biofiltration chamber. Both the treatment and bypass flows are combined in the outlet area prior to discharge from the structure. BioPod units without an internal bypass are designed such that only treatment flows enter the treatment structure. When the system has exceeded its treatment capacity, ponding will force bypass flows to continue down the gutter to the nearest standard catch basin or other external bypass structure.

The BioPod system can be configured as a tree box filter with tree and grated inlet, as a planter box filter with shrubs, grasses and an open top, or as an underground filter with access risers, doors and a subsurface inlet pipe. The optional internal bypass may be incorporated with any of these configurations. In addition, an open bottom configuration may be used to promote infiltration and groundwater recharge. The configuration and size of the BioPod system is designed to meet the requirements of a specific project.

Inspection & Maintenance Overview

State and local regulations require all stormwater management systems to be inspected on a regular basis and maintained as necessary to ensure performance and protect downstream receiving waters. Without maintenance, excessive pollutant buildup can limit system performance by reducing the operating capacity of the system and increasing the potential for scouring of pollutants during periods of high flow.

Some configurations of the BioPod may require periodic irrigation to establish and maintain vegetation. Vegetation will typically become established about two years after planting. Irrigation requirements are ultimately dependent on climate, rainfall and the type of vegetation selected.

Maintenance Frequency

Periodic inspection is essential for consistent system performance and is easily completed. Inspection is typically conducted a minimum of twice per year, but since pollutant transport and deposition varies from site to site, a site-specific maintenance frequency should be established during the first two or three years of operation.

Inspection Equipment

The following equipment is helpful when conducting BioPod inspections:

- Recording device (pen and paper form, voice recorder, iPad, etc.)
- Suitable clothing (appropriate footwear, gloves, hardhat, safety glasses, etc.)
- Traffic control equipment (cones, barricades, signage, flagging, etc.)
- Manhole hook or pry bar
- Flashlight
- Tape measure

Inspection Procedures

BioPod inspections are visual and are conducted without entering the unit. To complete an inspection, safety measures including traffic control should be deployed before the access covers or tree grates are removed. Once the covers have been removed, the following items should be checked and recorded (see form provided on page 6) to determine whether maintenance is required:

- If the BioPod unit is equipped with an internal bypass, inspect the contoured inlet rack and outlet chamber and note whether there are any broken or missing parts. In the unlikely event that internal parts are broken or missing, contact Oldcastle Stormwater at (800) 579-8819 to determine appropriate corrective action.
- Note whether the curb inlet, inlet pipe, or – if the unit is equipped with an internal bypass – the inlet rack is blocked or obstructed.
- If the unit is equipped with an internal bypass, observe, quantify and record the accumulation of trash and debris in the inlet rack. The significance of accumulated trash and debris is a matter of judgment. Often, much of the trash and debris may be removed manually at the time of inspection if a separate maintenance visit is not yet warranted.
- If it has not rained within the past 24 hours, note whether standing water is observed in the biofiltration chamber.
- Finally, observe, quantify and record presence of invasive vegetation and the amount of trash and debris and sediment load in the biofiltration chamber. Erosion of the mulch and biofiltration media bed should also be recorded. Sediment load may be rated light, medium or heavy depending on the conditions. Loading characteristics may be determined as follows:
    - Light sediment load – sediment is difficult to distinguish among the mulch fibers at the top of the mulch layer; the mulch appears almost new.
    - Medium sediment load – sediment accumulation is apparent and may be concentrated in some areas; probing the mulch layer reveals lighter sediment loads under the top 1” of mulch.
    - Heavy sediment load – sediment is readily apparent across the entire top of the mulch layer; individual mulch fibers are difficult to distinguish; probing the mulch layer reveals heavy sediment load under the top 1” of mulch.

Often, much of the invasive vegetation and trash and debris may be removed manually at the time of inspection if a separate maintenance visit is not yet warranted.

Maintenance Indicators

Maintenance should be scheduled if any of the following conditions are identified during inspection:

- The concrete structure is damaged or the tree grate or access cover is damaged or missing.
- The curb inlet or inlet rack is obstructed.
- Standing water is observed in the biofiltration chamber more than 24 hours after a rainfall event (use discretion if the BioPod is located downstream of a storage system that attenuates flow).
- Trash and debris in the inlet rack cannot be easily removed at the time of inspection.
- Trash and debris, invasive vegetation or sediment load in the biofiltration chamber is heavy or excessive erosion has occurred.

Maintenance Equipment

The following equipment is helpful when conducting BioPod maintenance:

- Suitable clothing (appropriate footwear, gloves, hardhat, safety glasses, etc.)
- Traffic control equipment (cones, barricades, signage, flagging, etc.)
- Manhole hook or pry bar
- Flashlight
- Tape measure
- Rake, hoe, shovel and broom
- Bucket
- Pruners
- Vacuum truck (optional)

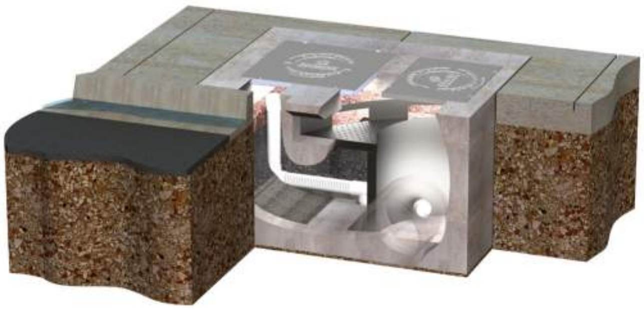
Maintenance Procedures

Maintenance should be conducted during dry weather when no flows are entering the system. All maintenance may be conducted without entering the BioPod structure. Once safety measures such as traffic control are deployed, the access covers may be removed and the following activities may be conducted to complete maintenance:

- Remove all trash and debris from the curb inlet and inlet rack manually or by using a vacuum truck as required.
- Remove all trash and debris and invasive vegetation from the biofiltration chamber manually or by using a vacuum truck as required.
- If the sediment load is medium or light but erosion of the biofiltration media bed is evident, redistribute the mulch with a rake or replace missing mulch as appropriate. If erosion persists, rocks may be placed in the eroded area to help dissipate energy and prevent recurring erosion.
- If the sediment load is heavy, remove the mulch layer using a hoe, rake, shovel and bucket, or by using a vacuum truck as required. If the sediment load is particularly heavy, inspect the surface of the biofiltration media once the mulch has been removed. If the media appears clogged with sediment, remove and replace one or two inches of biofiltration media prior to replacing the mulch layer.
- Prune vegetation as appropriate and replace damaged or dead plants as required.
- Replace the tree grate and/or access covers and sweep the area around the BioPod to leave the site clean.
- All material removed from the BioPod during maintenance must be disposed of in accordance with local environmental regulations. In most cases, the material may be handled in the same manner as disposal of material removed from sumped catch basins or manholes.

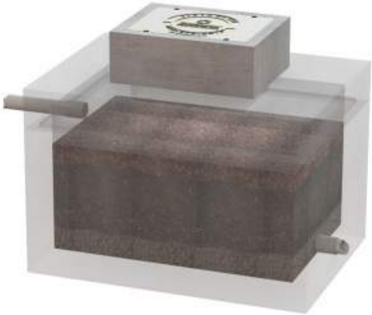
Natural, shredded hardwood mulch should be used in the BioPod. Timely replacement of the mulch layer according to the maintenance indicators described above should protect the biofiltration media below the mulch layer from clogging due to sediment accumulation. However, whenever the mulch is replaced, the BioPod should be visited 24 hours after the next major storm event to ensure that there is no standing water in the biofiltration chamber. Standing water indicates that the biofiltration media below the mulch layer is clogged and must be replaced. Please contact Oldcastle Infrastructure at (800) 579-8819 to purchase the proprietary StormMix™ biofiltration media.

BioPod Tree Module



BioPod Media Module

BioPod Planter Module



BioPod Media Vault

BioPod Inspection & Maintenance Log

BioPod Model________________________ Inspection Date____________________

Location____

Condition of Internal Components Notes:

☐ Good ☐ Damaged ☐ Missing

Curb Inlet or Inlet Rack Blocked Notes:

☐ Yes ☐ No

Standing Water in Biofiltration Chamber Notes:

☐ Yes ☐ No

Trash and Debris in Inlet Rack Notes:

☐ Yes ☐ No

Trash and Debris in Biofiltration Chamber Notes:

☐ Yes ☐ No

Invasive Vegetation in Biofiltration Chamber Notes:

☐ Yes ☐ No

Sediment in Biofiltration Chamber Notes:

☐ Light ☐ Medium ☐ Heavy

Erosion in Biofiltration Chamber Notes:

☐ Yes ☐ No

Maintenance Requirements

☐ **Yes - Schedule Maintenance** ☐ **No - Schedule Re-Inspection**

BIOPOD™ SYSTEM

WITH STORMMIX™ MEDIA

OUR MARKETS

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R-TANK OPERATION, INSPECTION & MAINTENANCE

Operation

Your ACF R-Tank System has been designed to function in conjunction with the engineered drainage system on your site, the existing municipal infrastructure, and/or the existing soils and geography of the receiving watershed. Unless your site included certain unique and rare features, the operation of your R-Tank System will be driven by naturally occurring systems and will function autonomously. However, upholding a proper schedule of Inspection & Maintenance is critical to ensuring continued functionality and optimum performance of the system.

Inspection

Both the R-Tank and all stormwater pre-treatment features incorporated into your site must be inspected regularly. Inspection frequency for your system must be determined based on the contributing drainage area, but should never exceed one year between inspections (six months during the first year of operation).

Inspections may be required more frequently for pre-treatment systems. You should refer to the manufacturer requirements for the proper inspection schedule.

With the right equipment your inspection and measurements can be accomplished from the surface without physically entering any confined spaces. If your inspection does require confined space entry, you MUST follow all local/regional requirements as well as OSHA standards.

R-Tank Systems may incorporate Inspection Ports, Maintenance Ports, and/or adjoining manholes. Each of these features are easily accessed by removing the lid at the surface. With the cover removed, a visual inspection can be performed to identify sediment deposits within the structure. Using a flashlight, ALL access points should be examined to complete a thorough inspection.

Inspection Ports
Usually located centrally in the R-Tank System, these perforated columns are designed to give the user a base-line sediment depth across the system floor.

Maintenance Ports
Usually located near the inlet and outlet connections, you'll likely find deeper deposits of heavier sediments when compared to the Inspection Ports.

Manholes
Most systems will include at least two manholes - one at the inlet and another at the outlet. There may be more than one location where stormwater enters the system, which would result in additional manholes to inspect.

Bear in mind that these manholes often include a sump below the invert of the pipe connecting to the R-Tank. These sumps are designed to capture sediment before it reaches the R-Tank, and they should be kept clean to ensure they function properly. However, existence of sediment in the sump does NOT necessarily mean sediment has accumulated in the R-Tank.

After inspecting the bottom of the structure, use a mirror on a pole (or some other device) to check for sediment or debris in the pipe connecting to the R-Tank.

R-TANK OPERATION INSPECTION & MAINTENANCE

If sediment or debris is observed in any of these structures, you should determine the depth of the material. This is typically accomplished with a stadia rod, but you should determine the best way to obtain the measurement.

All observations and measurements should be recorded on an Inspection Log kept on file. We've included a form you can use at the end of this guideline.

Maintenance

The R-Tank System should be back-flushed once sediment accumulation has reached 6" or 15% of the total system height. Use the chart below as a guideline to determine the point at which maintenance is required on your system.

R-Tank Unit	Height	Max Sediment Dept
Mini	9.5"	1.5"
Single	17"	3"
Double	34"	5"
Triple	50"	6"
Quad	67"	6"
Pent	84"	6"

Before any maintenance is performed on your system, be sure to plug the outlet pipe to prevent contamination of the adjacent systems.

To back-flush the R-Tank, water is pumped into the system through the Maintenance Ports as rapidly as possible. Water should be pumped into ALL Maintenance Ports. The turbulent action of the water moving through the R-Tank will suspend sediments which may then be pumped out.

If your system includes an Outlet Structure, this will be the ideal location to pump contaminated water out of the system. However, removal of back-flush water may be accomplished through the Maintenance Ports, as well.

For systems with large footprints that would require extensive volumes of water to properly flush the system, you should consider performing your maintenance within 24 hours of a rain event. Stormwater entering the system will aid in the suspension of sediments and reduce the volume of water required to properly flush the system.

Once removed, sediment-laden water may be captured for disposal or pumped through a Dirtbag™ (if permitted by the locality).

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ENVIRONMENTAL
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Step-By-Step Inspection & Maintenance Routine

1) Inspection

a. Inspection Port
  i. Remove Cap
  ii. Use flashlight to detect sediment deposits
  iii. If present, measure sediment depth with stadia rod
  iv. Record results on Maintenance Log
  v. Replace Cap

b. Maintenance Port/s
  i. Remove Cap
  ii. Use flashlight to detect sediment deposits
  iii. If present, measure sediment depth with stadia rod
  iv. Record results on Maintenance Log
  v. Replace Cap
  vi. Repeat for ALL Maintenance Ports

c. Adjacent Manholes
  i. Remove Cover
  ii. Use flashlight to detect sediment deposits
  iii. If present, measure sediment depth with stadia rod, accounting for depth of sump (if present)
  iv. Inspect pipes connecting to R-Tank
  v. Record results on Maintenance Log
  vi. Replace Cover
  vii. Repeat for ALL Manholes that connect to the R-Tank

2) Maintenance

a. Plug system outlet to prevent discharge of back-flush water
b. Determine best location to pump out back-flush water
c. Remove Cap from Maintenance Port
d. Pump water as rapidly as possible (without over-topping port) into system until at least 1"
   of water covers system bottom
e. Replace Cap
f. Repeat at ALL Maintenance Ports
g. Pump out back-flush water to complete back-flushing
h. Vacuum all adjacent structures and any other structures or stormwater pre-treatment systems that require attention
i. Sediment-laden water may be captured for disposal or pumped through a Dirtbag™.
j. Replace any remaining Caps or Covers
k. Record the back-flushing event in your Maintenance Log with any relevant specifics

ACF ENVIRONMENTAL
LET'S GET IT DONE

R-Tank Maintenance Log

Site Name:____________________________ **Company Responsible for Maintenance:**____________________________

Location:____________________________ **Contact:**____________________________

System Owner:____________________________ **Phone Number:**____________________________

Date	Location	Depth to Bottom	Depth to Sediment	Sediment Depth	Observations/Notes	Initials

For more information about our products, contact Inside Sales at 800.448.3636 or email at info@acfenv.com

Section 11

Conclusion

11.0 Conclusion

This site has been designed to meet the 2016 *KCSWDM*. The site incorporates stormwater management and water quality facilities to treat stormwater draining from the site. Stormwater calculations and modeling conform to King County standards.

It was determined using these criteria that:

- The water quality facility has been designed per both the King County Enhanced Basic Water Quality and Sensitive Lake Protection Menus.
- The flow control facility has been designed per the King County Conservation Flow Control (Level 2) standard.
- Pipe networks are designed to be of adequate size to effectively convey the 25-year storm event and to contain the 100-year storm event.

This analysis is based on data and records either supplied to or obtained by AHBL. These documents are referenced within the text of the analysis. The analysis has been prepared using procedures and practices within the standard accepted practices of the industry. We conclude that this project, as schematically represented, will not create any new problems within the downstream drainage system. This project will not noticeably aggravate any existing downstream problems due to either water quality or quantity.

AHBL, Inc.

Charles H. Stout, PE
Project Engineer

CHS/lsk

May 2021

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